WAREHOUSING PRACTICES AND FACTORS INFLUENCCING MISMATCH IN STOCK RECORD AND PHYSICAL STOCK

by

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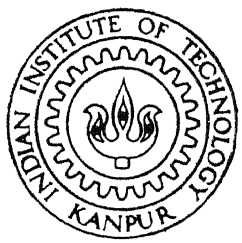

DEPARTMENT OF INDUSTRIAL AND MANAGEMENT ENGINEERING

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

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WAREHOUSING PRACTICES AND FACTORS INFLUENCING MISMATCH IN STOCK RECORD AND PHYSICAL STOCK

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MARCH 1997

IME-1997-M-SRI-WAR

THIS WORK IS DEDICATED TO

My Parents

&

My Siblings

CERTIFICATE

It is to certify that the work contained in the thesis entitled **"WAREHOUSI PRACTICES AND FACTORS INFLUENCING MISMATCH IN STOCK RECO AND PHYSICAL STOCK"** by **Santosh Kumar Srivastava (Roll No. 9511415)**, has b carried out under my supervision and that this work has not been submitted elsewhere fo degree.

28 March, 1997

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ABSTRACT

The deviation between physical and computer stocks not only affects the inventory cost but also affects whole business significantly. Computers are used extensively today for giving due date of shipment to customer, purchase, stock assignment and order pickup etc. For all these purposes it is assumed that computer stock is equal to physical stock. But if this assumption is not valid then this system can not work properly. The focus of present work is to identify the factors, which affect the deviation between physical and computer(or paper) stock record.

We selected multiple case study method due to nature of present work. We studied the product structure, warehouse configuration, procedures and control systems in warehouse management, and their impact on deviation between physical and computer(or paper) stock records, for four major manufacturing organisations of the country

The data obtained from organisations under study was analysed to identify the factors influencing deviation between physical and computer stocks. We identified nine distinct factors, viz. Product structure, Computerisation, Physical verification system, system of storage of items, Quality inspection policy, Access to store, Issue system, Measurement error and Coding system; which influence mismatch errors and analysed their impact.

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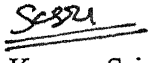

April 9, 1997 Santosh Kumar Srivastava

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1

INTRODUCTION

1.1 Introduction:

Production orders are frequently issued without verification that material needed for the orders are available for use. This occurs because one or more of the following assumption are made:[Ramond]

1)Inventory records that show material available on hand are accurate.

2) Materials available on hand are in usable condition.

3)Vendors will make delivery according to their promises.

4) Materials delivered by vendors will meet specifications.

5) Materials delivered by vendors will be available for use at the moment it is delivered to the plant.

If any of the above assumptions are not valid then there will be problems in meeting the production plan.

The present work analyses the factors which affect the validity of first two assumptions one and two above, in a warehouse. We shall concentrate on the study of mismatch between the physical stock and the recorded stock either in computer or in manual stock records.

1.2 Definition of "Deviation between the Physical and Computer Stocks":

Physical stock is quantity of item actually present in the store and computer stock is the stock of item shown by computer record.

In the present work we have assumed that there exists a deviation between physical and computer stocks for an item when one or more of the following condition arises:

a) Quantity of item physically present in store is different than the computer stock. Physical stock can be both less or more than the computer stock. In both the cases there will be deviation.

b) Quantity of item present physically in store is not fit for use. It may be due to high shelf life of item, environmental conditions not fit for storage, unusable size of item present in store etc.

c) The location of storage of item is not known, i.e. items may be physically present in store but can not be retrieved easily.

For condition one, there will be clear deviation of physical stock from computer stock. The cases two and three has also been treated as cases of deviation between physical and computer stocks. This is due to our inherent assumption behind computer stock that quantity recorded is available to the user for usage.

From now onwards in this work "mismatch" and "deviation between physical and computer stocks" will be used as synonym.

In present work following two types of mismatches have been considered:

a) Items showing discrepancy between physical and computer stocks. This type of mismatch is considered only as "excess" or "shortage" without considering level of difference in quantities between physical and computer stocks for the item.

b) Mismatch in quantity for an item between physical and computer stocks. In this category we have considered the difference between the physical and computer stocks for the item.

1.3 The effect of deviation between physical and computer stock:

The cost to business of inaccurate inventory records can be immense particularly when the term "cost" is taken in the broad sense, including more than just out of pocket expense. It is far more than just cost of finding the inventory errors and correcting them.

a) Impact on systems that use inventory data:

1.3.a.1) Material requirement planning:

MRP depends on accurate inventory records. In fact because this planning tool tends to replace manual judgement with computer programs, the presence of poor inventory

information may result in a situation that is worse than under the manual system. An inventory error that understates inventory will cause orders to be placed too soon. This results in excess inventory, shortage of storage space and unnecessary costs and investments. When inventory error overstates the quantity available on hand, the result is often delayed reorders, shortages, expediting and late deliveries to customers. Late delivery and other forms of poor customer service tend to drive customers away. Lost opportunity costs can be significant, sometimes driving a company out of business[Young(1991)].

In one of the companies, covered under our study, we were informed that sometimes one of the major product "transformer" is ready for shipment except due to non availability of small items like nuts and bolts etc., it gets delayed. Most of the time reason is that while computer records are showing stock available in warehouse, physically item is out of stock. Penalty for late delivery are generally 0.25% of selling price per week in this company and such delays can reduce the margins considerably.

1.3.a.2) Financial systems:

Since inventory is an asset, general ledger software usually reflects the on hands balance in the company's books. When the on hand inventory records are wrong, the ledger values are incorrect and the asset value shown are incorrect causing discrepancy in the balance sheet.[Young(1991)]

1.3.a.3) Order booking system:

Modern order booking system often calculates product availability, taking into account exiting stock on hand. If current on hand balance are overstated, availability will be overstated and customers will be given promised shipments dates that can not be met. Further when stock on hand are overstated, reorder from the factory will be delayed making the shortage situation worse. On the other hand when inventory are understated, customers are given delivery date later than it could be. This makes business less competitive and reduces the chance of getting orders.[Young(1991)]

1.3.a.4) Order Quantity:

When physical and computer stocks are same, then order can be placed in the EOQ. But when there is stock-out, orders have to be placed in emergency. As emergency orders are

generally smaller than EOQ, item will be received in smaller lots than EOQ. This results in higher inventory cost.

We observed in one of the organisation which we studied when items are required under emergency then sometimes they are transported plane in very small lots than normal lot received by trucks.

1.3.a.5) Stock Assignment And Order Pickup:

In a computerised stock assignment and computerised pickup system such as described by Agarwal[1995] and Bansal[1995], dissimilarity cost is considered. Dissimilarity cost is the cost incurred when item which are frequently retrieved together in the same order are not stored close to each other. It is in-built assumption in their work that while calculating dissimilarity cost, the record of locations is correct. But if there is any mismatch then dissimilarity cost calculated will not be correct, on the basis of which storage location is selected later in their works. The worst case will be there when the location given by computer for storage of new item is already filled by some other item due to mismatch of location. Higher will be the mismatch, lesser will be the applicability of these works. At the time of retrieval also if there is mismatch of location, then optimal solution based on above methods will not be optimal. Because when picker will go at the location to withdraw the item, it will be not there. So the picker will have to return back and find new location of withdrawal. This adds to the cost and time delay in retrieval.

b) Impact On Users:

When inventory records are incorrect, systems are affected, but more important, people are affected in their daily working life. The effect of mismatch on various users will be as below:

1.3.b.1) Production Planning And Control:

This department is responsible for planning production and monitoring achievement against its plan. Production planning and control is directly affected when inventory records are incorrect. Poor inventory records requires more frequent changes in production planning causing considerable nuisance in the actual functioning of the planning

Production plan become obsolete with each shortage and must be redone frequently. This frequent change in production plan is more due to internal problems than the need to accommodate customer order changes. And those internal problems, more often than not, revolve around inventory errors.

1.3.b.2) Purchase:

Mismatch in inventory leads to emergency orders to be placed. Due to emergency normal procedure of asking quotations from different suppliers and choosing the lowest quotation can not be followed. This leads to suppliers taking undue advantage of this emergency situation. Also the ordering cost shoots drastically. In such cases Purchase department is required to contact supplier continuously to know the status of material in case of emergency requirement case. It was reported that in the case of absolute emergency purchase persons go to supplier personally and bring the item with them. This all can be avoided if there is no emergency requirement of the items.

Inventory errors can also place an undue emphasis on vendor delivery cycles, some times causing buyers to choose vendors more for their speed than for the quality or price of their products. When inventories are accurate, deliveries can be more accurately planned and emphasis on vendor selection can be adjusted.

1.3.b.3) Quality control:

Quality control suffers when emergency jobs must be inspected quickly, often under pressure to accept the product despite minor flaws.

We observed in one of the organisation which we studied that 100 items were taken in unauthorised manner without being okayed from quality, by production in last seven months from receipt area. Latter these were rejected by quality. But as these were already consumed by production so quality had to accept these defective items.

1.4 Savings Attributable To Improved Accuracy:

Savings will result in case of improved accuracy, as shown in table 1.1. This has been reproduced from [Young(1991)], who had reported it from an unpublished document of Catalyst, USA, Inc.

Table 1.1 Savings Attributable To Improved Accuracy

Sl. no.	Benefit	Savings
1.	Elimination of time looking for lost material	Labour cost
2.	Elimination of annual physical inventory saves not only the labour required to count but also avoids the need to close the business while counting is in progress	Labour cost Customer service
3.	Reduced safety stocks. When inventory is accurately known, safety stocks are needed only to cover variability in supply and need not allow for inventory surprises	Inventory space cost Inventory losses Labour cost
4.	Debt service cost. When inventory is reduced, a one time favourable cash flow occurs, which can be used to retire outstanding debt.	Management cost
5.	Reduced purchasing activity. Accurate inventory eliminates surprises and therefore the need for emergency purchase orders and change notices.	Management cost
6.	More accurate customer promises because of more accurate inventory information.	customer service
7.	More accurate inventory records and more accurate customer promises reduces the need for premium-rate shipment (both incoming and outgoing)	Transportation cost
8.	More accurate shipments. Reduced returns, happier customers and fewer losses.	Labour cost Inventory losses Customer service
9.	More accurate bills of lading and invoices.	Labour cost Customer service.

1.5 Literature review:

Young(1991) has dealt in great detail about the problem of deviation between physical and computer stocks. He has mentioned following reasons of error in paper driven, computerised system:

1. The initial or beginning inventory can be wrong, after physical verification.
2. Working from document, the receiver, the put away person, or the picker can misread part identity or quantities.
3. The receiver and picker must count items, and can miscount.
4. Counting done by receiver or picker can be recorded incorrectly or can be recorded against the wrong item on either the receiving worksheet or the pick list.
5. The picker can misread the picking location number.
6. The material handler can record the wrong storage location.
7. Any of the transactions can be lost or misplaced as they travel between the user and computer.
8. Any of the recording done by receiver, the material handler or the picker can be illegible.
9. Any of the transaction can be keyed incorrectly

Young has suggested automatic identification like bar coding, radio frequency identification, magnetic strip, magnetic ink character recognition to reduce the error of data entry, which is most important reason of deviation in his view.

Michaels (1977) has estimated typical manual data entry error rates at about 1 in every 400 characters.

Allais, (1982) has estimated error rate for bar code entry as 1 per 3 million character records.

Tompkins(1988) has stated that availability of the item in the warehouse can be checked by one of following two identities of item:

1. Physical Identity:

Each item has a specific identity, characterised by weight, ability to be handled etc. By virtue of this identity the item can be counted or measured, if the location of the item inside the store is identified. This corresponds to physical stock of the item.

If sufficient storage locations are not provided then item may be misplaced and hence may not get located within the warehouse.

The system of allocating two or more items in the same physical location increases risk of

(1) Human error associated with retrieving the wrong parts and

(2)Items not being found.

2. Paper Identity:

This identity for all intents and purposes is dimensionless. In practice, an item's paper identity, ergo it's stock record, is used more frequently to determine the available stock on hand than for an actual physical check at the known stock location(s).

There is a difference between these two identities due to the fact that they generally follow entirely different paths through warehouse The physical item follows the material handling path through the warehouse and is found on the floor or in storage bins within the warehouse. The paper item, with the possible exception of a tag, follows the path that eventually leads to its being stored as part of a record in a file drawer, computer data base, or some other convenient storage and retrieval system.

If there is lag between these two flows and the subsequent updating of records, the mismatch is generated. The effect of mismatch will vary, depending upon time lag between these two identities.

Mismatch can also be due to human error by stock handler in writing down stock withdrawals on a card or a data processing operator making entry at a computer terminal.

Control of access to warehouse will help in reducing mismatches.

Saboo(1981) have given following reasons of mismatch:

a) Mismatches due to handling of material:

Due to handling there will be some loss of material. For raw materials like coal, bauxite, wood etc., there may be shortage in quantity due to loss of moisture, wind and deterioration due to storage over a long period of time. This loss will depend upon material, mode of transport, handling and method of storage.

There may be appreciation in the weight due to absorption of moisture and in such cases the physical stock will be more than the computer stock.

b)Mismatches due to clerical errors:

The error in posting may cause mismatches as below:

1. Material received not entered at all or wrongly entered.
2. Material received not entered due to wrong or incomplete paper with receipt.
3. Issue not entered at all or entered against wrong part code.
4. Material issued in different quantity than entered into computer record.
5. Wrong unit of measurement written on requisition.
6. Material returned to store but return indent not posted.

c) Theft and pilferage:

Another reason of mismatch can be due to theft or pilferage from the store.

Tersine(1977) is of the view that the foundations of any inventory control system are input data and control records, which must be current and accurate. Inventory control is based on the accuracy of records of inflows and outflows. Poor records and data can destroy a perfectly designed control system. Whether manual or computerised, record accuracy is critical to operation. Two requirements of accurate records are:

1. A good system for recording all receipts and disbursements.
2. A good system for auditing record accuracy, which discovers and corrects the causes of errors.

Unauthorised and undocumented transactions must be stopped, or control is virtually impossible. An enclosed and locked stockroom with access only to authorised personnel can do much to control undocumented transactions. A clean and well ordered storage area will reduce lost and misplaced items.

1.6 Research Objective:

There will be some factors which will increase the chances of deviation between physical and computer stocks. On the other hand, there will also be some other factors which

will reduce the chances of mismatch or will rectify the already existing deviations between physical and computer stocks of items.

The objective of present work is to identify the factors having impact on the mismatch in items stocked in a warehouse.

1.7 Methodology:

We adopted a qualitative approach to the research. Among the various methods for doing qualitative research, we selected multiple case study method. The following sections explain the rationale of adopting case study method for the research.

1.7.1 Choice of qualitative approach:

A qualitative approach is more suitable for an in-depth study of a process which ranges across complex variables[Morgan(1980)]. The objective of this study is to find the factors affecting the mismatch in a warehouse. This requires an in-depth study of various procedures of warehouse management as well as the physical aspects of warehouse. For mismatch it is difficult to find exact reason and most of the time an inference to understand reason of mismatch have to be drawn on the basis of incomplete and partial information "Qualitative research seeks description for what is occurring in the field.[Van(1982)].

1.7.2 Choice of case study method:

Following types of research strategies are used by social scientists[Yin(1984)]

1. Experimental investigations.
2. Survey research method based on questionnaire and interviews.
3. Manipulation of secondary data.
4. Historical studies.
5. Case studies.

Yin(1984) Comparing case studies to other research strategies, identifies three conditions for the choice of appropriate strategy:

1. The type of research questions posed.
2. The extent of control an investigator has over actual behavioural events, and
3. The degree of focus on contemporary as opposed to historical events.

Yin(1984) further added that "a case study is best when a "how" or "why" question is being asked about a contemporary set of events, over which the investigator has little or no control."

In present work it is tried to found "how" the record of item goes wrong and "why" this record goes wrong. This "why" has been tried to understand in the form of various factors which affect the inventory accuracy. This study relied heavily on the memory and experience of persons interviewed in addition to the available records. On the basis of these factors, it was felt that case study method would be the most appropriate method of conducting the study.

In this research we selected multiple cases. According to Yin(1984), "the evidence from multiple cases is often considered as most compelling, and the overall study is regarded as being more robust."

1.7.3 Selection Of Cases:

The criteria for choosing the number of case studies to be carried out were:

1. Time and resources available.
2. Degree of accuracy required.

In different warehouses the reasons and levels of mismatches vary significantly so within available time frame, we decided to carry out study in four organisations.

Following criteria were used to select the organisations;

1. Organisation should have good enough number of components in warehouse. For this we selected organisations with around 3000 or more components in their warehouse.
2. Organisation should have warehouse management procedure.
3. The end use of item stored in warehouse should be as much different as possible.

On the basis of these three criteria four leading organisations in their field of operation in India were selected in Kanpur, Lucknow and Allahabad

1.8 Data Collection:

A formal approval from management was taken to conduct the research in the respective organisations. Following checklist was prepared for study in each organisation.

a) Physical Structure Of Warehouse:

1) Nature of product: Data were collected for end use of items, batch size of receipt and issue etc.
2) Warehouse Configuration: For this data were collected for different stores in organisation, system of storage within warehouse under study, single or multiple location storage, locked area or unlocked area etc.

b) Procedures For Warehouse Operations:

1)Receiving: Information were obtained for procedure of receiving and various errors during receiving.
2) Quality inspection: Information was collected about type of tests carried out i.e. destructive, non destructive or no inspection. Data were also collected for mismatches due to sample drawn for quality inspection.
3) Storage: Procedures of storage in warehouse and errors during storage was studied.
4) Issue: Information about system of raising requisition, issue of item from issue store were collected. Information was also collected for various errors possible during normal issue or emergency issue for each organisation.
5) Purchase: System of purchase of items was studied.
6) Coding system: The logic behind coding system was studied for each organisation. Special consideration was given for chances of two codes for same item and its impact on mismatch.

c) Control Systems in Warehouse Management:

1) Computerisation: In each organisation the information about various entries into computer and reports obtained from computer was obtained.
2) Physical verification system: Different systems of physical verification in each organisation were studied. Also the study was done to get idea about number of items physically verified in a year, reconciliation procedure etc.

Data collection was done through unstructured interview with store manager and warehouse personnel. Other sources of data collection were:

1. Record of physical verification.
2. On line system for the data about computer stock of an item.
3. Tags attached with lot showing quantity for the purpose of "quantity reported".
4. For getting physical stock we either counted items ourselves or used electronic counter for small items.
5. Study of locations for mismatch of locations and shelf life.
6. Requisitions raised by production.
7. Records of issue.
8 Direct observation of different activities for warehouse operation.

As this work was aimed at finding reasons of mismatch in each organisation, so it was observed that initially, interviewees were not comfortable in disclosing the data, specially people of lower hierarchy. But after establishing rapport and friendship with them the data collection was facilitated.

1.9 Introduction of companies selected for study:

1.9.1 DUNCAN industries Ltd. (Fertiliser division):

This company was established in 1968 by IEL. Latter it was taken over by DUNCAN. group Product of this company is marketed in the company under brand name "Chand Chhap Urea". The company is located in Panki Industrial area Kanpur.

1.9.2 TELCO (Lucknow):

The Tata Engineering and Locomotive Company Limited (TELCO) is a leading engineering organisation in the private sector in India. The company has presence in both commercial vehicle and passenger car segment. The company has manufacturing plants at Jamshedpur, Pune and Lucknow. We selected plant located at Lucknow for our study.

Production at Lucknow plant was started in 1992. At present production of medium commercial vehicle (MCV), light commercial vehicle (LCV) and SUMO is assembled at Lucknow plant.

1.9.3 GEC Alsthom India(Naini Works):

This company is an established name in electrical equipment. The company is giving much emphasis on quality as a result of which meters unit of Paharpur works, Fusegear unit, Relay and control panel unit, two units of power transformer division at Naini and Cochin and Salt Lake works at Calcutta has got ISO 9001 certification.

For our study we selected power transformer division of company located at Naini, Allahabad. At this division company is trying to introduce new products in its product line. Recently the company is trying to manufacture 400 KV transformer. After getting success it will be included in a select group of manufacturers in India having the capability to manufacture 400 KV transformer.

1.9.4 LML Limited (Scooter Unit):

The product of the company is an established brand name in scooter market. The company has collaboration of PIAGGIO, Italy. At present it is investing a lot to triple the existing capacity of plant and facilities to reach an annual volume of six lakhs vehicles. The manufacturing plant of company is located at Panki. Industrial Estate, Kanpur.

1.9.5 Comparative performance of companies :

Comparative performance of three companies selected for our study, viz. TELCO, LML and GEC, for financial year ending in 1995 with respect to other leading companies of India is given in table 1.2. This has been reproduced from Business India (23 Oct.-5 Nov., 1995).

Table 1.2 Comparative performance of companies under study in financial year ending in 1995

Sl. No.	Company	Rank '95	Sales '95 (Rs. crore)	Rank '95	Profits '95 (Rs. crore)	Rank '95	Mkt. value '95 (Rs. crore)	Rank '95	Assets '95 (Rs. crore)	Rank '95
1.	TELCO	2	5044.22	2	318.95	4	8983.26	2	1354.89	10
2.	GECA	159	379.82	118	7.80	184	286.49	126	58.12	165
3.	LML	141	290.11	166	26.40	118	438.31	99	61.01	161

1.10 Organisation of thesis:

In chapter two of this work our observations of product structure, warehouse configuration, procedures and control mechanism for warehouse management for organisations under study has been discussed.

In chapter three details of observations for the level of mismatch and various practices affecting mismatch in each of the organisation under study has been discussed.

In chapter four analysis has been done on the basis of observations in organisations. A set of nine factors likely to have impact on mismatch has been identified and the impact of these factors has been analysed in view from the information collected from the four organisations.

In chapter five we have summarised our findings about factors having impact on mismatch.

2

WAREHOUSES AND WAREHOUSING PRACTICES IN ORGANISATIONS UNDER STUDY

In this chapter we shall describe for each of the four organisations of our study, the salient features of the warehouse physical structure and management practices. For this purpose, our observations are classified in the following categories:

1) Warehouse description.

2) Procedures for warehouse operation.

3) Control systems for warehouse management.

2.1. DUNCAN INDUSTRIES LTD. (FERTILISER DIVISION)

(Referred as DUNCAN)

2.1.1 INTRODUCTION:

"DUNCAN" is a major producer of fertilisers in the country. The responsibility of the stores is to provide raw material and other accessories for the production of fertiliser as well as for supplying the components for maintenance of the equipment as and when need arises. Total value of the inventory lying in the store is around 32 crore rupees.

2.1.2. WAREHOUSE DESCRIPTION:

Following are the details about physical structure of the warehouse.The structure is described as follows

I. Nature of items present in warehouse.

II. Warehouse configuration.

I. Nature Of Items Present in Warehouse:

- **End Use of items:** Most of the items of this store are used for plant maintenance.
- **Number of items:** The number of items in store is around 40000.
- Total value of inventory lying in store is around 32 crore rupees.
- Items are standard items of supplier.
- **Batch sizes of receipt and issue:** Generally the batch size is less than 10.

II. Warehouse Configuration:

There are around 6000 locations where about 40000 different items are stored. Every location within the purview of the store is numbered.

Store is divided in following different areas:

I. CN area.

II. H racks.

III. General Area.

IV. Locked area.

V. Open area.

The physical configuration of each area are as below:

2.1.2.2.1 CN Area:

Very heavy items to be lifted by the crane etc., will be kept in CN area.Total number of items in CN area are around 700 This area is further divided as below:

a) CN -1: In this area electrical items like motors etc. are kept. As the crane will not reach in the extreme left so light items like small motors etc. are stored in the side which can be handled manually.

b) CN-2: In this area long items,e.g. shafts are kept.

c) CN-3: In this area different type of safety valves are placed.

d) CN-4: In this area heavy items are kept.

e) CN-5: In this area very high value equipment are kept. These are kept without opening their packing.

2.1.2.2..2 H racks:

In these racks , generally items of weight more than 10 Kg. are kept. These items are generally moved with the help of fork lift. More than one items are kept at one location. These

racks are numbered as H-37, H-39 etc. where H stands for "heavy". Around 450 items are lying in this area.

2.1.2.2.3 General area:

In this area small items are kept. This area is divided into two stories. Items kept in this area are handled manually. In this area the items kept are components of equipment kept in CN area or H racks. Generally the parts of same equipment are placed near to each other. At one location more than one parts are kept. One meter length of rack is divided into 2, 4 or 6 divisions depending upon the size of part to be kept at these locations. Different stories in a rack are numbered from 'A' to 'K' except 'I' due to it's resemblance with '1'. An example of a location in this area is 127 - A 1/2 representing 127th rack, 1st one meter length, story 'A' and 2nd partition of 1st one meter.

2.1.2.2..4 Locked Area:

The items kept in this area are either very high value items or preferable items like bearings etc. Small items which can be of personal use are also kept in here. As the chances of pilferage or cost of these items are very high, these items are kept locked and only store persons are authorised to enter in here.

2.1.2.2.5 Open Area:

Very big items like large pipes of diameter 24 cm and length 15 feet or so, drums etc. are kept outside the warehouse in an open yard.

2.1.3 Procedures For Warehouse Operation:

In this section we will describe the various procedures adopted for operation of warehouse. These procedures for this company are:

I. Receiving.

II. Storing

III. Issue and

IV. Order placing.

2.1.3.1 Receiving:

After receiving the item in store quantity is physically verified to find any discrepancy between quantity supplied and quantity given on paper received from supplier with lot. We observed that generally lot size is small (less than 10 generally). As generally the items received are standard items of supplier so no quality testing is carried out.

After receiving,item are handed over for binning at the proper location.

2.1.3.2 Storing:

If item is already stored then new lot is also stored with old lot at the same location. If item is not lying in store then it will be stored at some free location and location of storage is recorded on location card, maintained on paper. No location is permanently fixed for any item.

2.1.3.3 Issue System:

When maintenance needs some item , it raises its requisition on paper. On the basis of this requisition store finds the location of the item and issues the required item to maintenance. After that issuing entry of issue will be made both in computer and ledger maintained on paper. Requisition raised by maintenance is kept by store for further record.

Some salient features of this issue system are as below:

a)Number of issues per day:

Around 200 items are issued per day. In 1st six months of financial year of 1996-97 total issue were 20641.

b)Refusals:

Refusals are those requisitions which could not be served. In first six months of financial year 96-97 total refusals were 1001 which is around 4.8% of total requisitions.

To study the reasons of refusals we collected a sample of 42 refusals. In this 22 items had been ordered but the order had not been received, 19 items had been indented but order had not been given and in one case the item had been out of stock.

Items for which indent has been raised for more than three months were 28.

c) Special issue requirement:

Some items can be issued only to that person who is authorised for its use. Electrode is one such item.

Policy spares are items which are very costly and are used less frequently. For issue of these items signature of Engg. Manager is required.

2.1.3.4 Order Placing:

As soon as the store finds that some item has gone below Order Level (O.L.) in ledger stock, indent for that material will be send to supply department.

The supply department has list of suppliers for that item and it will seek quotations from suppliers. After that supply department will select the supplier and will place orders with them to supply the items. The purchase order is made in four copies by the supply department. These are send to suppler, accounts, store and one is retained by supply department.

During this procedure if stock of that item goes below the minimum order level then reminder will be sent to supply department for the urgent supply of that part to stores. Order level and minimum supply levels are prefixed for every item.

2.1.4 Control Systems In Warehouse Management:

In this section we will study the following systems for warehouse management in this organisation:

I. Computerisation.

II. Coding system.

III. Physical verification system.

2.1.4.1 COMPUTERISATION:

a) Entries into computer:

Following information are entered into computer:

1)All the receipts are entered into computer.

2)All the issues are entered into computer.

3)This system does not have at present the location map of the items lying in the store but manager store informed us that new software with area map is under development. At present location map is maintained on paper.

4)At the time of issue search for location of storage is done from location record on paper.

b) Reports:

Following different reports are generated from computer:

1)At the end of every month list of items having negative balance is prepared.

2)List of stockouts is prepared by computer.

3)Computer data sheets showing balance and transaction are send before the physical verification of a group of items. This data is used for the purpose of physical verification.

2.1.4.2 CODING SYSTEM:

The code consists of two components. "Part code" identifies the part and the second component "Unit code" identifies the unit of measurement. The coding system is as below:

2.1.4.2.1 Part code:

8 digit code is used in this organisation for the purpose of part identification. The code for any item consists of three groups, as shown in figure 2.1

CODE:

Digits	XX	YYY	ZZZ
Group	1	2	3

Figure 2.1 Coding System for DUNCAN

a)First group "XX":

First two digits show group of item. e.g.:

14 to 47 are common consumable items like:

16 for cement.

17 for nits and bolts.

18 for tools.

20 for electrodes.

43 for chemicals etc.

60 is for use in Urea and Ammonia Plant

50: Same as 60 but policy spare.

51: Same as 61 but policy spare.

61 is for electrical item.

62 is for instruments.

63 is for the offside.

65 is for equipment mainly used in offside but can also be used in Urea and Ammonia.

52: Same as 62 but policy spare.

53: Same as 63 but policy spare.

55: Same as 65 but policy spare.

b)Second group "YYY":

Second group YYY represents the subassembly of XX.

c)Third group "ZZZ":

Third group ZZZ represents components of subassembly YYY.

2.1.4.2.2 Unit Code:

Every item is also given a unit code which represents the unit in which it is purchased or issued. These are like:

01 number

02 pairs

03 sets

16 litre

19 Kg.

20 meter

2.1.4.3 SYSTEM OF PHYSICAL VERIFICATION:

To remove the discrepancy between physical and computer stocks the physical verification is carried out. In this organisation physical verification is carried out throughout the year group wise so that every item is physically verified once in a year. Before the physical verification of the group, computer data sheet showing balances and transactions for the items of group is obtained.

There is no dispute if the computer and physical stock tallies. In case of deviation between physical and computer stock item goes under dispute and then it is handed over for reconciliation.

Total number of persons assigned for the job of physical verification are seven. This consist of three teams of 2 persons each and one person for reconciliation.

Number of items physically verified per day:

Physical verifiers informed us that in eight hours each team is able to physically verify 75 - 80 items. More time is taken for big items because most of these item are not having legible code, so problem of identification arises.

Items physically verified per year:

Out of total of around 40000 items present in store 33000 items are physically verified every year, the value of which is around 99.33 % of the total value of inventory lying in store.

2.2 TELCO, Lucknow (Referred as TELCO)

2.2.1 Introduction :

The second organisation of our study was a leading automobile company of India. It is producing trucks. The plant is of comparatively recent origin so changes are taking place in store management practices.

2.2.2 Warehouse description:

Following are the details about physical structure of warehouse:

2.2.2.1 Nature Of Items Present In Warehouse:

a) Use of items:

Items are used for the assembly of trucks. The end product is standard design multimodel item.

b)Lot size of receipt and issue:

Generally lot size is around 100.

c)Consumption pattern:

Items are used for assembly of trucks which is produced as per production plan. So the demand for each item is known in advance.

2.2.2.2 Warehouse Configuration:

There are following different stores in this organisation:

I. Central material store

II. Rejection and scrap area store.

2.2.2.2.1 Central material store:

The central material store (CMS) is divided into three stores on the basis of three major product groups:

I. MCV store.

II. SUMO store.

III. LP 407 store.

Each of the above are having two stores:

I. Receiving store.

II. Issue store.

Store of our study:

We selected for our study the oldest store out of these three stores "MCV store". The reason behind selecting this store for our study was that store management procedure have been comparatively well established.here.

Unless otherwise specified the details are given about store management practices of this store.

2.2.2.2.1.1 MCV Store:

Number of components:

The approximate number of components in this store are around 3000.

Physical configuration of "MCV store" is as below:

a) Receiving store:

Items are kept on rollers lying in the receiving area. There is no location number marked at present in the receiving area. We observed that this is creating a big problem for quality in getting sample and keeping back in lot after testing.

The other general observations in this area were that the rollers are insufficient and a good enough number of parts are kept on the ground in a fairly random manner. A number of parts were lying on the floor below the rollers due to overturning of bins.

This store is unlocked.

b).Issue store:

Every location in this store is numbered.

For every item location of storage has been permanently fixed.

General configuration of issue store :

I. Rows 1 to 7 are for storing metallic bins for heavy items of wt. more than approx. 1 kg. as per our subjective observation. These bins are handled by forklifts.

II. Rows 8 to 21 are for storage of type 1, type 2 and type 3 plastic bins. In these racks material is kept ready for line feeding for next seven days or so in small bins and extra material is kept in bigger bins above these locations in overflow area. For next preparation , item is taken from these overflow bins and also excess new material will go in these overflow bins. Type 1 bins are handled manually while type 2 and type 3 bins are moved with the help of forklift. The items of same group are kept in one row like:

10th row is for washers.

11th row is for clamps, clips and springs.

12th row is for socket and coupling components.

17th to 21st rows are for cowl items.

- Bulky items like seat, radiators are stored at a separate area as they require large area for storage and hence could not be accommodated in the racks No location is numbered in this separate area.
- The shelf life of batteries is very less and strict implementation of FIFO is of prime requirement. Also there are problems in handling the batteries if they are stored on racks. Considering these factors batteries are stored on ground in a separate area. For the purpose of implementation of FIFO an identifier showing "NEXT REMOVAL" is put on the batch to be issued.
- There are some items which are to be sent with the vehicle before dispatch like some booklets etc. These are kept in a separate area in store.
- Previously there was some problem of pilferage of some items like spanner etc. To control this problem now these items are kept in a locked area which include around 30 items including spanners, keys etc.

2.2.2.2.2 Rejection and scrap area store.

I. **Rejection store:**

- Items getting rejected from quality are is stored in rejection store. Items are kept in bins on ground in this store.
- No location is marked.
- This store is unlocked.

II. **Scrap area store:**

- After taking decision to scrap, items lying in rejection store, are stored in scrap area. Also items rejected on line are stored in this area.
- Items are kept in bins on ground in this store.
- No location is marked.
- This store is unlocked.

2.2.3 Procedures For Warehouse Operation:

In this section we will describe various procedures adopted for operation of warehouse. The main procedures are:

I. Receiving

II. Quality inspection.

III. Storage

IV. Issue.

2.2.3.1. Receiving :

- **Number of receipts per day:**

  Per day around 100 items are received.

- **Receiving procedure:**

When the material is received at the gate, a goods inward note (GIN) is prepared showing the quantity, part number and supplier's details etc. After this paper work item is moved to receiving area. The receiving area staff verifies the quantity supplied physically against the quantity written on the paper. After verification received quantity is entered in

computer records. If there are any discrepancies found in quantity of item supplied then a "shortage note" or "excess note" will be prepared.

Finally this item is transferred in bin and is kept over roller lying in receiving area.

- **Tag:**

A tag is attached with each lot showing:

I. Part number

II. Quantity

III. Date of receipt

IV. Suppliers detail

V. GIN number.

2.2.3.2 Quality Inspection :

After receiving the item GIN is offered to quality for the inspection.

- **Withdrawal of sample:**

The quality searches the location of lot in receiving area, for which GIN has been offered and withdraw the sample as per the sampling plan. As locations are not marked in receiving area, considerable amount of time is lost in locating the lot.

- **Type of tests carried out:**

For quality inspection following type of tests are carried out:

I. Destructive testing for metallurgical inspection.

II. Non destructive testing for dimensional inspection.

After inspection by quality ,item is either rejected or accepted. Depending upon the case the item is transferred to rejection store or issue store.

- **Information about result of quality test inspection:**

After completing the inspection quality persons sign on the tag attached with the lot and tear away the relevant portion of the tag which shows that the item is " Quality OK" ; "Rejected" ; or needs to be "reworked".Quality enters the information in the computer stock and after that GIN is returned to the material department .

2.2.3.3 Storage in Issue Store :

- **Transfer from receiving store to issue store:**

After item being OKayed the quality tears the "Rejected" and "Rework" parts of the tag and puts signature on the tag These items are moved to issue store Responsibility for storing every item in issue store has been permanently assigned to different stock handlers of store. These stock handlers keep on searching in the receiving area for the items assigned to them and okayed by quality. They transfer these items from receiving store to issue store

The present system of tearing of the tag to inform about item being okayed by quality is creating following problems for stock handlers:

I. A lot of their time is spent in finding items for which the tag have been torn.

II. The store people get information of item accepted from quality through tearing of tag only. As they don't get this information in any other way so it is likely that they may miss to transfer some items to central material store. Following examples illustrate this:

   a. Item no. 3505 8901 3703 ; Mounting cup was lying checked in inspection area for one month. Quantity stated on this is 102 while actual quantity present is 29 only. After this lot, 1300 more pieces in 4 lots had come till the time this observation.was made

   b. Item no. 3522 5400 97; Rubber below was lying in receiving area for last three months (130 numbers). After this lot, 7 more lots of 550 items have been cleared till the time this taking observation.was made Its consumption in six months is only 48 units.

- **Storage into issue store:**

From receiving store items are transferred to issue store. For every item locations has been permanently fixed. Item will be kept at its assigned location. Every location is numbered in the central material store.

2.2.3.4 ISSUE:

Number of issue per day:

On average about 500 items are issued every day.

- **Responsibility for transfer of item from store to line:**

Line feeders have responsibility to supply item on line.

- **Need generation for issue:**

When line feeders observe that some item is going to be finished on line then they come to store and take the item to transfer it to line

Issue is done according to one of the following two procedures:

I.Normal issue.

II.Emergency issue.

I. Normal issue

When there is a requirement of material on the production line the line feeders draw it from issue store and supply it on the production line.

- **Record of issue:**

Previously the line feeders had to make an entry in an issue register giving details about the part number, part name and quantity withdrawn. Later this was entered into computer to record the issue.

Now this organisation is implementing the system of bar coded slip for issue. These slips will be lying in the bin and at the time of withdrawal line feeders have to hand over these slips to issue section. These slips will be bearing details about part number, quantity withdrawn and location of withdrawal. The issue section will scan these bar coded slips to enter issue in computer system.

II. Emergency issue:

If the item is not available in issue store but is present in the receiving area under inspection, then there is a system of diary issue. In this system line feeders have to take the consent of quality and have to enter details about the item withdrawn in a register. Details are entered GIN no., part code and quantity withdrawn. After the inspection by quality, quantity taken earlier is shown as issued under the diary issue in the computer.

2.2.4 Control systems for warehouse management:

The following control systems are used for management of warehouse in this organisation:

I. Computerisation.

II. Coding system.

III. Physical verification system.

2.2.4.1 Computerisation:

a)Input and data entry.

Following different entries are made into computer:

1. Entry is made at the time of receiving.
2. Results of quality inspection are entered into computer.
3. Entry is made of issue.
4. In new system with bar coding location map will be provided in computer.

b)Reports obtained from computer:

No special reports are obtained in this organisation from computer system.

2.2.4.2 Coding system:

12 digit numeric coding system is used in this organisation.. The three main parts of code are as below:

I. **Vehicle group:** First four digits represent model in which part will be used.

II. **Main assembly:** Next four digits represent main assembly in which item will be used.

III. **Sub assembly or serial number of component:** Last four digits represent sub assembly or serial number of components in the subassemblies.

2.2.4.3 Physical verification system:

Following two methods are used for physical verification in this organisation:

I. Periodic physical verification.

II. Daily stock adjustment.

a)Periodic physical verification:

- **High value items:**

High value "A" class items like engine, tyre, radiator etc. are not stored in store under study. These items are under the control of PPC. For these items physical verification is carried out at every three months. As these items are issued based on production so the reasons of any discrepancy have to be found out and stock tallied.

- **"B" and "C" class items:**

For the "B" and "C" class items which are stored in MCV issue store, physical verification is carried out at the end of financial year. During physical verification production is stopped and persons working on assembly line also take part in physical verification process. No reason is recorded for discrepancy. The aim of the physical verification is to compute the value of inventory lying on line (WIP) and store for the purpuse of valuation of assets balance sheet of that year.

b) Daily stock adjustment:

One person is appointed in material department to make physical verification round the year also. Generally he adjusts the physical and computer stocks of about ten items under shortage daily.

2.3 GEC Alsthom (Naini Works) (Referred as GEC)

2.3.1 INTRODUCTION:

This organisation is a leading manufacturer of power equipment like transformers, switch gear etc. in India. This is the only ISO 9000 certified company of our study.

2.3.2 Warehouse Description:

The details about physical structure of the warehouse of this organisation are as below:

2.3.2.1 Nature Of Product:

The organisation is different from other under study, in warehouse management practices mainly due to nature of its product.

Product:

The company is making power transformers. The selling price of one 220 KVA transformer is around 1.7 crores while selling price of one 400 KVA transformer is more than 2 crores. The material cost is around 70% of selling price and company is working at around 10% profit level. Due to such high cost of product they take orders in advance for a period of about one year.

Delivery dates and penalty:

On the basis of delivery dates, production phasing for next one year is planned. Here the concept of delivery date is very important because penalty is imposed if they are not able to deliver transformer on delivery date. This penalty is around 0.25% to 0.5% of selling cost per week of delay, Due to this penalty only the company incurred a loss of Rs. 15,45,000 as compare to the total cost of items sold of Rs. 4,97,31,000 in first 6 months of financial year covered in this study. So it is clear that role of planning is of utmost importance in this company. For the proper planning and to reduce inventory it is very important to have accurate record of inventory.

Value Analysis

In the power transformer division around 75% of the items value wise are job specific i.e. they are procured as per the design for particular job only. The A-B-C analysis for power transformer division is as given in table 2.1.

Table 2.1 "A-B-C" analysis for GEC

Class	No. of Items	% Value
A	6-7	60%
B	100-200	20%
C	around 3000	20%

2.3.2.2 Warehouse Configuration:

In the same plant power transformer, switch gear and distribution transformer are manufactured. Switch gear is a completely different division while distribution transformer was

previously under power transformer division From April 96 distribution transformer and power transformer have been organised as different departments for the purpose of better control, although the distribution transformer and power transformer are similar in respect of items, coding system etc.

Physically there are three separate stores as follow:

I. Power transformer store.

II. Distribution transformer store.

III. Switch gear store.

Reason of having different stores for power transformer and distribution transformer:

Switch gear is a different store because more than 60% items are different between switch gear and power transformer.

Between power transformer and distribution transformer 70% hardware's are common. But value wise "C" class items carry only 20% value. For "B" class items which carry around 20% of total value around 40% items are common. For "A" class items only transformer oil is common item. So although around 75% items in number are common between power transformer and distribution transformer value wise only items of around 20% value are common. The reasons for having power transformer and distribution transformer as different stores are as below:

I. Being different PPC departments for power transformer and distribution transformer divisions already, better control and fixing of responsibility is possible for any stockout or carrying higher level of inventory.

II. The store will be nearer to the point of use.

We carried out our study in power transformer store of the power transformer division for this company,which will be described in next subsection:

2.3.2.2.1 Power transformer division stores:

Number of items in store: Around 3000 items are present in store.

- In the power transformer division there are three stores:
  - I. Receiving store.
  - II. Rejection store.
  - III. Issue store.

Receiving store: Each location in receiving store is numbered. This store is locked and only receiving store persons have access to this store.

Rejection store: Items are stored in this store after being rejected by quality. This store is locked and only quality has access to this store.

Issue store:

On average in this store inventory of 5 crores is lying.

There are a number of issue stores Some of them are as below:

2.3.2.2.1.1 Main Issue Store:

In the main issue store there are basically three types of items:

a) Hardware group.

b) Connectors group.

c) Miscellaneous group.

In this store similar items are kept at nearby locations e.g. M S hex screws are kept at nearby locations. Only one item is kept at one location. We observed that in this store at around 20% locations item is present, but code of item stored is not mentioned at the location. At other locations item code, old item code and description of the part is written at the location. At present there is no location map available in computer and also no location has been fixed for any item. New item received are stored near to similar items stored at some free location. Store manager informed us that location could not be assigned to a part on permanent basis as in this store approximately 40% items are job specific. So these items are not always lying in store. These are stocked in store only when the related job is manufactured. So at a location, it is possible to store different items during different times

Store of our study:

The details given in this work for this organisation are for main issue store only unless otherwise stated.

2.3.2.2.1.2 OLTC Store:

Items are kept without opening the packing in the store and job number is written on every packing.Locations are not numbered in this store but items being very big they can be easily identified. This store is locked.

2.3.2.2.1.3 Porcelain Store:

Racks are numbered like PS-1,2,...5. Partitions within racks are further numbered as 1/1,...1/18 ; 2/1,....5/18. At every location only one item is stored. This store is locked.

2.3.2.2.1.4 Packing Material Store:

This store is locked.

2.3.2.2.1.5 Copper Scrap Godown:

This store is locked.

2.3.2.2.1.6 Open Yard Storage:

Tanks are stored in open area. Floor is cemented with proper slope to prevent accumulation of water. Locations are not marked in this area.

Yoke channels are stocked in open yard. No location is marked in this area. Store manager informed that there is problem of rusting this item .

Radiators and high voltage bushings are stocked in packed condition in open area. Job number is written on packing

Reason of having different issue stores

Store manager informed us that within power transformer division the reason of having different issue stores is to store one type of item in one store and also to control access to these stores. Items like OLTC, tank, yoke channel, radiators and high voltage bushings are stored in different stores due to their big sizes.

2.3.3 Procedures for warehouse operation:

In this section we will describe various procedures adopted for operation of warehouse. Following procedures are used in this company :

I. Receiving.

II. Quality inspection.

III. Storing

IV. Issuing and

V. Order placing

2.3.3.1 RECEIVING:

Supplier will send a report of dispatch of items to purchase department and will let them know the date of arrival and mode of transport etc. Around 50 items are received every day.

a)Main gate entry:

When an item is received at the main gate of the factory an entry is made in on-line computer system to show the receipt of material in factory. A sample record is shown in table 2.2.

Table 2.2 Record description at main gate in GEC

1.	challan No.
2.	Supplier Name
3.	Date
4.	Part Name
5.	Quantity
6.	Mode of transportation

The advantages of main gate entry record are as below:

I. As soon as item is received inside the factory every one knows that item has been received. If that item is urgently needed by production then an emergency inspection will be carried out and it will be issued to production.

II. It helps to prevent misplacementof the items inside the factory. If item is misplaced then as it is known that item had come inside the factory it will be located.

III. If some challan is missed, then to show that item was received inside the factory, help of entry at main gate is taken. At least one challan is reported missing each month.

b)Receipt section working:

After entry at main gate the items are moved comes to receipt section. During unloading, if some packing is found damaged then it is noted. After unloading, physical

verification of items received is carried out. If there is any discrepancy between items actually received and items received on paper, then a discrepancy note will be prepared in four copies and will be sent to accounts, purchase and supplier by receipt section. We observed that most of the items received are big and in small batches(batch size is generally less than 10). So if there is any discrepancy between quantity actually received and quantity as per paper then chances are very high for its detection. Most of the small items come in standard packing from supplier.A tag will be attached with the received lot showing details given in table 2.3.

Table 2.3 Details of tag attached with received lot in GEC

1.	Part Name
2.	Part Code
3.	Quantity
4.	Supplier
5.	Date

Yellow tags are used for switch gear items and white tags for transformer items.

After receiving the item will be kept at some free location in receipt section. Location number of this location will be written on challan.

2.3.3.2 Quality inspection:

After receiving the challan from receipt section quality will pick the sample from the lot for quality inspection from the location mentioned in the challan. After inspection, quality will return back the sample to its location in receiving area

Type of tests carried out:

Generally non destructive tests are carried out to test electrical properties.

Information about result of quality test inspection:

After inspection, quality will tear "OK" or "Rejected" portions of the tag, similar as in the case of TELCO. But the information about result of quality inspection is sent to issue store through post inspection computer entry by quality.

After inspection by quality if item has been rejected then it will go to the rejection and scrap area store. While transferring from receipt store to issue store no physical verification is carried out.

2.3.3.3 Storage in Issue Store:

After item has been okayed by quality it is transferred to issue stores, as follows:

a)Storage in main issue store:

In this store no location is assigned permanently to any item. If item is already present in store then it will be mixed with previous lots. If item is not already stored in the store, then it will be stored at any free location, near the items of same group. Broadly items are categorised in following three groups:

I. Hardware group.

II. Connectors group.

III. Miscellaneous group.

No record of location of storage of item is kept. Location search at the time of issue is based on the memory of persons working in main issue store.

b)Storage in other issue stores:

Other items will be stored in respective stores provided for their storage. No record of location of storage is maintained.

2.3.3.4 Issuing:

Items are issued as per one of the following procedure:

I. Emergency issue.

II. Normal issue.

2.3.3.4.1 Procedure of emergency issue:

If some item is required to be issued to production line from receiving area itself instead of from issue store, then after quality inspection it is issued from receipt store to production, and quantity issued is written on challan. After receiving the challan in issue store the quantity written on challan will be entered in computer record to show its issue to production.

Only staff of receiving store can issue an item from this area. The receiving section is locked and only receiving store staff has access to this store.

2.3.3.4.2 Normal issue procedure:

Number of issues: Per day around 80 items are issued.

Issue procedure:

When any item is required, the production people raise requisition advice (RA) on computer. The various entries of RA are shown in figure 2.2.

Issue No.							
Dept. Code				Requisition Number			
Movement Code				Requisition Date			
Requisitioner							
No.	Item Code	Description	Unit of Measurement	Kardex Quantity	Required Quantity	Issued Quantity	Job No.
Raised By		Authorised By		Issued by		Received By	

Figure 2.2 Kardex record in GEC

We observed that generally production is raising RA on computer and after that they take its printout on the paper. This RA on paper is send to issue store. The store will send this item to the production person who has raised this RA.

But as per our observations, many times the production persons are also going inside the store and issuing the items themselves as per their requirements, mainly in the case of general items which are not job specific.

False stockouts:

Location number is not given in requisition advice "RA". We observed many times main issue store person spends more than half an hour in searching for the items present physically in the store. In the extreme cases stock out is shown for items which are physically present in store. Frequency of these false stockouts is at least once in a day.

Record of issue:

After issue the issue store staff will enter on that RA the issue number and issue quantity both in computer as well as on paper. This RA on paper will be kept for future record.

If some item has not been issued in required quantity then in the evening a list of these items will be prepared. There is one person in purchase department to deal with these cases only. He will place orders, follow them, arrange for immediate inspection by quality on receiving and then issue to production people.

Till the RA is not served fully it will continue to blink in computer to show that it has to be served.

2.3.4.3 Order Placing For Purchase Of Items From Supplier:

Imported items:

When any new order is received from customer, transformer is designed as per his requirements. On the basis of design a bill of material for that order is prepared. This bill of material is given to purchase and production. Purchase places the orders taking into consideration the production plan on the basis of production phasing for imported items. Lead time for imported items is around two months. After receiving, one of the major material, copper is given to subcontractors to make core of required size.

Indigenous Job specific items:

Planning also prepares rolling plan for next three months. In this rolling plan, start and end dates of every activity is shown. On the basis of this rolling plan, purchase sends order to suppliers for job specific items so that it is received before its requirement.

General non job specific items:

For the purchase of general items which are not job specific, consumption in last three months is computed by the computer. If stock has gone below a prefixed level, then the requirement in coming three months are assessed order is placed with supplier.

2.3.4 Control Systems In Warehouse Management:

We studied the following control systems which are used for management of warehouse in this organisation and which are likely to have impact on mismatch:

I. Computerisation.

II. Coding system.

III. Physical verification system.

2.3.4.1 COMPUTERISATION:

a)Entries:

In this organisation following information are entered into the computer:

- All incoming material information are entered into computer at main gate and receiving section.
- Results of quality testing are entered in computer.
- Requisitions are raised on computer.
- All the issues are recorded in computer.

b)Reports:

Following different reports are generated from computer.

- At the end of every month, list of items having negative balance is prepared.
- List of slow moving and non moving items is prepared at the end of every month.
- Computer is used for placing order for common consumable items to get consumption pattern.
- List of items under shortage is given by computer.

2.3.4.2 Coding System:

Previously 6 digit code was used, but due to increase in number of items, 7 digit code was introduced. On further increase in number of items, 98 group and 99 groups were introduced in the 7 digit code. 98 group was for general items and 99 group was for items going out of factory for repair etc. In these 98 and 99 groups Sl. nos. 1, 2, 3.....were given to different items. However as these codes were not able to provide information about component detail a 9 digit code has been introduced now. The details of this 9 digit code are shown in figure 2.3.

Code

Digits:	X X	X X	X X X X	X
Groups:	1	2	3	4

Figure 2.3 Coding System for GEC

1) First two digits show group of item.
2) Next two digits show subgroup of item.
3) Next four digits show dimensions of item for general items and job number for job specific items.
4) Last digit will show the supplier.

There are 97 major groups of items, like:

01 for heat exchanger.

02 for paints, adhesives and consumable.

03 for insulation oil.

10 for core lamination.

50 for valves.

66 for instruments.

71 for relays.

96 for miscellaneous non standard items.

97 for miscellaneous non standard items ordered by PPC.

In 01 group for heat exchanger:

3rd and 4th digits show kW divided by 25.

5th to 8th digits show indent number.

9th digit: 1 for Reliance make, 2 for Reynolds make, 8th for imported and 9th for any other.

In 02 group for paints, adhesives and consumable etc.

3rd and 4th digits: 01 for primer paint, 02 for intermediate paint, 03 for finish paint, 04 for thinner, 05 for putty.

5th digit: 1 for enamelled, 2 for epoxy, 3 for Duco, 4 for Aluminium, 5 for hot oil resistant, 6 for high temperature paint.

6th, 7th and 8th digits: Catalogue number or colour shade number.

In 77 subgroup for electrode

5th digit: 1 for copper coated MS electrode, 3 for low hydrogen electrode, 4 for comet red electrode and 5 for S.S. electrode.

6th and 7th digits: Diameter of electrode in mm.

8th digit shows fractional part of diameter of electrode.

In 04 group for round winding copper wire:

3rd and 4th digits: Thickens of insulation paper.

5th and 6th digits: Diameter in mm.

7th and 8th digits: fractional part of diameter in mm.

In 19 group for ferrous raw material:

For Sheets and plates:

5th and 6th digits: Thickness in mm.

7th and 8th digits: fractional part of thickness In mm.

For Flats:

5th and 6th digits: Width in mm. divided by 5.

7th and 8th digits: thickness in mm.

For Steel wire mesh:

5th and 6th digits: Pitch in mm.

7th and 8th digits give SWG.

In 24 group for Ferrous hardware:

For Nuts and Lock nuts:

5th to 8th digits give max. diameter in mm, like M24 nut will be 0024.

For Bolts, Studs and Screws:

5th and 6th digits: Max. diameter of the thread in mm.

7th and 8th digits give length divided by 5 in mm.

So we observe that codes are representing the specifications of the item. Hence there could not be two different part codes for same item. If by mistake two part codes are generated for same item then it could be detected very easily. Two such cases are given below in which two codes were generated for same item but during half yearly physical verification this error was detected:

I. Code 243100109 St. Steel Hex. Nut M 10X1.5 was same as code 243200109.

II. Code 243100129 St. Steel Hex. Nut M 12X1.75 was same as code 243200129.

2.3.4.3 PHYSICAL VERIFICATION SYSTEM:

In this organisation following two systems of physical verification are prevailing:

I.Half yearly physical verification for every item is carried out.

II.Cycle counting is carried out round the year for high value items.

2.3.4.3.1 Half Yearly Physical Verification System:

This year half yearly physical verification was carried out from 1st Oct. to 20th Oct. 96. Physical verification was carried out between 11.30 AM and 4.30 PM. This was declared zero hour for issue and receipts. Production was required to draw the material before 11.30 AM and RA should be raised two days in advance. Different teams were made for different item groups.

For any item for which RA was not raised and was lying outside store, a tag showing "Store's Property" was attached. This was done to check double counting of items both as store inventory and WIP.

During physical verification the physical condition of item is also checked. For this A, B or C category is assigned to every item. "A" represents that condition of material is OK, "B" represents that cleaning is required and "C" represents that reinspection by quality is required. 5 to 6 hardware items are rejected every year after this reinspection. This rejection can be assigned to no consideration of FIFO in the issue policy, in this organisation.

If any discrepancy is found then its reasons are found. If manager store gets satisfied by reason of that discrepancy given by physical verifiers then it can be written-off. But if the people doing physical verification are unable to find satisfactory reason of discrepancy then the case will be handed over to a committee consisting of officers of senior position from materials, production and accounts They find the reason of discrepancy and take required action to write off that item. No item could be written off without giving reason of discrepancy.

2.3.4.3.2 Cycle Counting:

For high value items physical verification is done round the year by one specialist. In items covered under cycle counting method of physical verification in this organisation, more physical verification is carried out for items of more value. Cycle counting is carried out as per plan shown in the table 2.4, in this organisation:

Table 2.4 Plan for cycle counting in GEC

Item	Class	Total Material Content	Req. No. of Checks Per Year	Month of Checking		
Copper conductor	A	25%	3	Apr.	Jul.	Oct.
Transformer lamination	A	31%	3	Apr.	Jul.	Oct.
Transformer oil	A	9%	3	Apr.	Jul.	Oct.
Radiator	B	7%	2	Apr.		Oct.
Condenser bushing	B	4%	2	Apr.		Oct.
OLTC	B	5%	2	Apr.		Oct.
Mild steel	B	6%	2	Apr.		Oct.
Insulation	B	4%	2	Apr./May		Sept./Oct.

2.4 LML Limited (Scooter Unit): (referred as LML)

2. 4. 1 INTRODUCTION:

The fourth company of our study was another leading automobile company of the country. However product line is different here, as it produces two wheelers. Company is in operation for considerable number of years. Hence the processes have been stabilised fully for the store management. Reducing inventory is much more important for this company because its volume of production is very high.

2.4.2 Warehouse Description:

Following are the details about physical structure of the warehouse:

2.4.2.1 Nature Of Items Present In Warehouse:

Items stored in east block component store, the store under our study, has following characteristics:

a)Use of item: Items stored in this store are used for assembly of two wheelers. The end product is standard design multi-model item.

b)Lot size of receipt and issue:

Generally items are received and issued in lot size of more than 1000.

c)Consumption pattern:

Items are used for assembly of two wheelers which is produced as per production plan. So the demand of each item is known in advance

2.4.2.2 Warehouse Configuration:

2.4.2.2.1 Different stores of the organisation:

Following different stores are in this organisation:

1. The stores are categorised according to geographical location as below:
   I. East block Store and
   II. West block store.

   In East block mainly vehicle assembly is done.

   In West block mainly engine assembly is done.
2. In each of these two stores there are General store, Component store and Raw material store.
3. In each of these three stores mentioned in 2, there are import store, duty free store and Indigenous store.
4. In each of these stores mentioned above there are receipt, holding and rejection stores.

The reason of having different stores in east block and west block is to have store near the point of use. Also it helps in better accountability. But due to this, there is a duplication of items and facilities also. For example most of the items of general store are same for east block store and west block store.

Store of our study:

We studied the functioning of east block component store. So in this work details are given for east block component store for this organisation until and unless mentioned otherwise.

2.4.2.2.2 East block component store:

Total of around 3000 items are stored in the east block component store. This store is divided in following three stores:

I. Receipt store

II. Holding store and

III. Rejection store.

The configuration of these three stores are as below:

2.4.2.2.2.1 Receiving store:

In receiving store following areas for storage of different incoming item are provided:

a)Items Require Storage In One Bin:

Incoming items, like sheet metal parts, assemblies etc. which have to be kept in one bin, are placed in bins kept in receiving area on ground and also in three racks in holding store under the control of receiving store. All these locations are numbered. Locations for bins on ground are marked as A-1, A-2,. . . ; B-1, B-2,. . . . . .

b)Out station parts storage area:

There is one separate area in receiving store where out-station parts are kept in packed condition. The packing is not opened for the reason that if item will be rejected from quality then before sending item to supplier it has to be packed again. So for these items packing is opened only after being okayed from quality.

c)Small items storage:

There are metallic wire bins numbered S-1, S-2,. . . In these some small screws, bulbs, electrical items etc. are kept.

In racks numbered like R-A, R-B,. . . . R-G washers etc. are kept.

In racks R-B, R-C and R-D small items are stored. The volume of air to material is very high in this area. Our estimate for volume of air to material is around 4:1 in general. Also many items are lying at a location.

In bins on ground which are numbered 1,2,. . . . 60, items like screws some small assemblies, small rubber items etc. are kept. In these bins more than one item is present in one location in packed condition.

d)Plastic parts:

For big plastic parts which are made by moulding the chances of rejection are very less. So uninspected and quality okayed stocks are kept together in one part of store.

No - section in receipt store is locked.

2.4.2.2.2.2 Holding store:

In the holding store there are total of 12 racks. In each of the racks there are 7 storeys and 33 columns.

Bin size: The bins for storing the items are of the same size. We were informed by the manager store that this is due to the fact that production volume is very high so materials are received in big lots (generally more than 1000).

This store is divided into two areas:

I. FIFO section.

II. Non FIFO section.

2. 4. 2. 2. 2. 2. 1 FIFO SECTION:

This system is in use for rack number 10, 11 and 12.

Number of components:

Around 600 components are covered under the FIFO system.

Location Assignment:

No location is permanently assigned to an item of this section. On receiving new lot its location of storage is obtained from computer out of free available location. Record of every location is available in computer for this section.

Different lots are not mixed in this section and as the name of this section indicates items are issued on "First Come First Serve basis".

2.4.2.2.2.2.2 NON-FIFO section:

This section is in use for racks 1 to 9.

Number of items:

In this section around 2400 items are stored.

Location assignment:

Every stock handler has been assigned permanently around 350 items and a particular storage area in holding store. He is responsible for storage of items assigned to him in his area. No location is assigned to any of the item permanently. Neither any record of storage of item is kept. So this is working only on the basis of memory of stock handler. Different lots are mixed for same item in this section.

Neither FIFO nor NON-FIFO section is locked area.

2. Rejection store:

Rejected items are stored in this store in racks. Racks are similar to holding store. This section is locked and only staff of rejection and scrap area has access to this store.

2.4.3 Procedures For Warehouse Operation:

In this section we will describe the various procedures adopted for operation of warehouse. These procedures for this company are:

I Receiving.

II. Quality inspection.

III. Storage

IV. Requisition and Issue

2.4.3.1 RECEIVING:

- **Number of receipts per day:**

Per day around 250 to 300 items are received.

- **Receiving procedure:**

When item is received into store its challan is taken and on the basis of this a goods receipt note (GRN) is prepared on the computer. After preparing the GRN the quantity is physically verified and then item is taken inside the store in receipt section and kept at proper location. We observed that every time people of receiving area go and physically verify the quantity and only after that item is taken inside the store.

- **Packing:**

One important thing we observed that every item is received either in standard packing of supplier or components are tied together in a group of some reasonable numbers like 5, 10, 25 etc. This helps a lot in verifying the quantity received.

2.4.3.2 INSPECTION BY QUALITY:

After keeping the item in receiving area the GRN is offered to quality. The responsibility of providing sample to quality is of receiving store. After completion of inspection by quality, receiving store takes back the GRN and sample. Sample is then kept back in the lot. After receiving a lot 7 to 8 days are taken by quality to clear that item.

- **Type of tests carried out:**

For quality inspection following type of tests are carried out:

I. Destructive testing for metallurgical inspections

II. Non destructive testing for dimensional inspection.

After inspection by quality item is either rejected or accepted. Depending upon the case the item is transferred to rejection store or holding store.

- **Information about result of quality test inspection:**

In this organisation there is no system of tearing of tag by quality as was in the case of TELCO and GEC. The information that the item has been rejected or accepted is marked on GRN itself by quality. The receiving store gets information after getting GRN back from quality through this entry.

2.4.3.3 STORAGE:

- **Transfer of material to holding store:**

Material is transferred from receipt store to holding store after being okayed by quality. This transfer is done by receipt store people. Whole bin is transferred by fork lift Small components are transferred with the help of stagger.

2.4.3.3.1 Storage in FIFO section:

When material is received in FIFO section for storage then GRN is entered into computer. If there has been issue of item from receiving store then this quantity is adjusted and for the actual quantity received in holding store, locations of storage are provided by computer.

- **Assignment of location of storage:**

For the actual quantity received in holding store, number of storage locations required is found. This is on the basis of bin capacity for the item. This appropriate number of storage locations are assigned out of available free locations.

- **Bin capacity:**

Bin capacity is the maximum quantity of item that can be kept into one bin. Bin capacity for every item of store has been already fixed. This capacity was decided on the basis of considerations like volume of bin, weight that can be put into bin, the capacity of forklift to lift the weight.

2.4.3.3.2 Storage in NON-FIFO section:

- **Updating of computer stock:**

After being okayed by quality, material is transferred by receiving store persons, to person whom this item has been assigned for storage. Stock handler, whom this material has been assigned, will enter the GRN to update computer stock. If there has been issue of item from receiving store then this quantity will be adjusted. The actual quantity received in holding store will get added into computer stock.

- **Storage of item:**

The item received will be mixed with already existing lots of item. No location of storage has been permanently assigned to any item. Stock handler can store item anywhere in his area. No record of location of storage are kept. This is working just on the basis of memory of stock handler.

- **Number of items assigned to each stock handler:**

Each stock handler has been assigned around 350 items.

2.4.3.4 Requisition And Issue:

a)Requisition:

The production, prepares the production plan one day in advance, i.e., next day. On the basis of this production plan, requirements of different components for next day is calculated. Production also keeps some buffer stock on line. So while calculating the requirements for next day the required level of buffer stock to be kept is also taken into account. This requirement is send to store on paper as a requisition. The store issues the items on the basis of this requirement given by production.

b) Issue:

Number of issues per day: On average about 500 items are issued every day.

Issue is done according to one of the following two procedures:

I. Normal issue.

II. Emergency issue

2.4.3.4.b.1 Normal issue:

- **Bin for line feeding:**

The colour of store bins is blue while the bins which will go on line are of orange colour, to distinguish them from store bins. The bins which go on line generally contains around 20 different type of items.

The system of issue is described below both for FIFO and NON-FIFO sections:

- **FIFO section:**

For issuing items from FIFO section, the part number and quantity required is entered into computer. The computer gives the locations of items to be withdrawn and quantity to be taken from locations. These locations of withdrawal are selected strictly on the basis of FIFO, i.e. in order of date of arrival in the store.

After getting this list of locations and quantities to be withdrawn the store person goes to different locations one by one. At each location of withdrawal, he transfers quantity specified by the computer, in the bin for line feeding. Removal of items more than once from the store bin is possible if it does not become empty in a single withdrawal.

- **Non FIFO section:**

Only the person, to whom item has been assigned, is authorised to issue the item. He knows the location of storage of item. So he will go to locations one by one and will transfer item from store bin to bin for line feeding.

- **Packing:**

We observed that standard packing or bundle helps considerably in counting, during issue.

- **Transfer of bin from store to line:**

The bin prepared for line is transferred to line by PPC which is part of production. PPC is not authorise to draw any item from its location of storage from holding store.

2.4.3.4.b.2 System of Emergency Issue:

During normal issue, if some component is not available in the required amount in holding store, then a shortage list is prepared. If that item is available in receiving area then emergency quality inspection for that part is arranged. After being okayed by quality it will be issued in required quantity from receipt store to production. This issue can be done only by receipt store. Receipt store will prepare Receipt Store Slip (RSS) for this item issued from receipt store.

When lot will be transferred to holding store then with the GRN, RSS will also be attached. The RSS is prepared on computer so when holding store will enter GRN into computer, the actual quantity received in holding store will be shown after adjusting the quantity of RSS.

2.4.4 Control Systems in Warehouse Management:

We studied the following control systems which are used for management of warehouse in this organisation and which have impact on mismatch:

I. Computerisation.

II. Coding system.

III. Physical verification system

2.4.4.1 Computerisation:

2.4.4.1.1 Input and Data entry:

Following different entries are entered into computer:

1. Entry is made at the time of receiving.
2. Results of quality inspection are entered into computer.
3. Entry is made of receipt of item into store.
4. For FIFO section location of storage is provided by computer.
5. Entry of computer is made of normal issue.
6. Emergency issue are entered into computer.
7. Search of location of withdrawal is made by computer for FIFO section.

2.4.4.1.2 Reports obtained from computer:

Following different reports are obtained from computer.

1. At the end of every month a list of items issued to production and standard consumption of that part is prepared.
2. A list of negative balance is raised every day.
3. A list of slow moving and non moving items can be obtained from computer.

For this report the date after which slow moving or non moving details are required is to be entered. After this, entry of issued quantity after that date which can be overlooked has to be made. Then computer will give a list of items which have not been issued in quantity more than specified quantity after the specified date.

2.4.4.2 Coding system:

Coding system consist of three parts:

I. Main group.
II. Sub group.
III. Serial no of part.

Main group will be of two digits or single alphabet.

Subgroup: This will be of three digits.

Serial no: Number of digits in this group will be as per maximum serial number required

2.4.4.3 Physical verification system:

Following three methods are used for doing physical verification in this organisation:

I. Six monthly physical verification.
II. Daily verification by stock handlers.
III. Verification in FIFO section at zero balance.

a)Six monthly physical verification.

In this organisation there is a system of six monthly physical verification of stock. For every item of store physical and computer stocks are adjusted. Reasons of every discrepancy are found before write off.

b)Daily verification by stock handlers:

Holding store persons also do physical verification of around 4 items out of items permanently assigned to them every day. A record of this physical verification is kept by them.

c)Verification in FIFO section at zero balance:

In FIFO section when stock after withdrawal is shown nil by computer then it is also physically verified and any discrepancy found is adjusted.

3

OBSERVATIONS OF MISMATCHES AND PRACTICES AFFECTING MISMATCHES

The purpose of this study is to identify the factors influencing mismatch. Due to the nature of the stores, wide variety of practices and size of the warehouses, it is difficult to get an accurate estimate for the errors of different type in an identical format. So for this study, we decided to observe the mismatches by:

a) Overall level of mismatches, measured as the percentage of items showing discrepancy between computer (or manual) record and physical stock.
b) By taking samples of data, specific to a particular deviation, which may help us in understanding the reasons for the mismatch.

It may be noted that as the organisations have widely varying practices for record keeping, it was not possible to collect the information in the same format. Also as in each of the organisations, information had to be collected from different sources such as computer record, manual record, interview with store, production and other persons etc.; the level of confidence is different for each type of information.

In the remaining part of this chapter, we describe observations for the four organisations.

3.1 DUNCAN:

We have discussed our observations for mismatch in the stock for this organisation with respect to:

I. Level of deviation between physical stock and computer stocks.
II. Observations for various practices and related errors in this organisation.

3.1.1 The Level Of Deviation Between Physical Stock And Computer Stock:

3.1.1.1 Deviation in General Area:

In the first half of financial year 1996-97 total of 12720 items were physically verified. Discrepancy was found in 1494 cases. So there is deviation in 11.75% of items.

Physical verifiers informed us that generally 5 to 6 errors are detected by each team per day in general area. On the basis of information provided by people involved in physical verification the estimated error is 7 to 8%.

This error includes those items which may be lying physically but are not properly identified by the verification staff. This is true for mainly large items.

On the basis of above information we estimate average error to be around 10%.

3.1.1.2 Deviations in Lockup area:

People involved in physical verification informed us that for the items kept in lockup area generally error is found in one or two items per day. As on average 75-80 items are physically verified by them per day. So **error in lockup area is estimated to be** $= \frac{1.5X100}{75} \approx 2\%$.

3.1.2 Observations For Various Practices And Related Errors In This Organisation:

The following are practices responsible for mismatch in this organisation·

3.1.2.1 Error Due to Mismatch of locations:

If due to mistake item has been kept at a similar but different location like placed at 127 B 3/3 instead of 129 B 3/3 then this problem arises. Generally it is very difficult to trace the items misplaced in this manner and this error is detected only by chance. Also at a location as more than one item is placed, so while picking an item the person may place other item lying in that location in the nearby area and forget to keep it back causing such an error.

- **Result of sampling:**

To study the problem of item being kept at a location other than recorded, we collected

a sample of 1800 items and physically observed their locations of storage. We observed that 28 items were placed at locations different than location given by record.

- **Estimate by person doing reconciliation:**

Person doing reconciliation estimated that this is reason of mismatch in 15 - 20% of the cases.

3.1.2.2. Error Due To Issuing Other Item From The Same Location:

As at a location more than one item is present, chance exist of issuing wrong item from the same location. Store people accepted that many times they are not able to identify correct part at the location corresponding to the requisition. They can only identify the item with the help of tag on the item showing part number. The durability of tag itself is a great problem.

Estimate for error due to issue of wrong item from the location out of total issues:

- We studied 100 requisitions in a serial of one requisition book. We assumed that items asked for requisition in same quantity on same day twice are due to issuing wrong item from the same location. There were 8 such cases out of total 100 requisitions we studied
- The estimate of maintenance for wrong issue from same location was around 20% of total issues.

Fraction of mismatch due to issue of wrong item from the location out of total mismatches:

- Person doing reconciliation estimated that 10-15% of the total discrepancies reported can be assumed due to this reason.

3.1.2.3 Error Due To Entry Into Wrong Ledger or Arithmetic Error:

Person doing reconciliation estimated that around 5% cases of mismatches out of total mismatches reported are due to wrong entry into ledger or due to arithmetic error. This is generally corrected by tallying computer record with manual record.

3.1.2.4 Error Due To Night Issue:

The plant operates in night also while store persons are present only during day time. The store is locked during night and if plant persons require some item, they will take the key of store from shift in charge. They will draw the required item and will enter withdrawal into an issue resister. But it is possible that they might not post the entry. Chances are also that wrong item code may be entered in the register. Manager store on the basis of his experience

stated that in general production persons are not very interested in doing paper work, resulting in such error.

3.1.2.5 Error Due To Unauthorised Removal:

Person doing reconciliation estimated that in around 25-30% of the total mismatches reported, no specific reasons could be assigned by him for mismatch. Hence these items are generally written-off. We assume that this is due to requisition being not given for item withdrawn i.e. due to unauthorised removal including night issue not recorded.

3.1.2.6 Error Due To Difference Between Units Of Receipt And Issue:

As mentioned in 3.1.4.2.2 every item has a unit code of measurement. Problem may arise if units of issue and purchase are different. Some such examples are as below:

- **Unit of purchase is weight and unit of issue is number:**

We were informed by manager store that cotton duster is purchased in weight and although the weight of a single piece is between 35 to 40 gram, it is practically not feasible to issue the item by weight. These are issued by number. Due to this difference between units of issue and purchase last year around 1400 pieces were in surplus. Similar problem arises for nuts and bolts, which are also purchased by weight and issued by number.

- **Purchase is in pair/set but issue can be in single piece also:**

Some components are supplied by the supplier in pair or set only e.g. some belts are supplied in set of eight pieces So at the time of purchase the unit code is 02 or 03. But during issue if plant has not clearly mentioned in requisition whether one single piece or one pair/set is required then there are chances of mismatch both during issue and entry into computer of issue. Following example illustrates the problem mentioned above:

Item code 60.517.011, Oil Seal is purchased in set. One set consist of two pieces. For this item plant had given requisition for one piece. However during entry into computer issue of one set was entered. Due to this one piece has become excess.

- **Sampling for level of mismatch of error in items of different units of receipt and issue:**

We also studied a computer data sheet of items having different units of receipt and issue. In this sheet corrections were made after doing physical verification of items. Out of 100 entries we studied, there were corrections in 14 items.

- **Error due to different units of receipt and issue out of total errors reported:**

Person doing physical reconciliation for errors reported by physical verifiers estimated

that 10 -15% of the total discrepancies reported can be assigned to this reason.

3.1.2.7 Error Due To Cross Issue In Substitute Groups:

Cross issues are possible for the items which can be used in place of each other. Some examples of this type of items in this organisation are as below:

a) Bolts.

b) Gaskets.

c) S.S. Sheets.

d) Motors: As they look alike but different in codes and power ratings.

e)Rubber, 'O' rings: Nylon and Whiten are different materials than rubber but they look alike.

f) Torch cells: Ordinary and leak proof.

g) Metallic rings.

h)Oil seals.

- **Estimate by person doing reconciliation:**

Person doing reconciliation estimated that this is reason of around 15-20% of mismatch out of total mismatches reported by physical verifiers..

3.1.2.8 Problem Due To High Shelf Life:

Due to high shelf life many items are not in a usable condition. Four such observations are given in table 3.1.

Table 3.1 Observations for unusable items in DUNCAN

SL. No.	Observation
1.	65-903-802 rubber injection gaskets are physically damaged.
2.	65-903-803 rubber injection gaskets are physically damaged.
3.	65-903-813 rubber injection gaskets are physically damaged.
4.	65-903-830 rubber joint ring is physically damaged.

These items can not be used by plant, although physical and computer stocks are matching.

3.1.2.9 Problem Due To Not Implementation Of FIFO:

At present same item of different lots is stored at the same location and during issue no consideration to FIFO is given. Store manager informed us that, if the item is kept in two

boxes at same location, one inside and other outside, then people use to take the item from the outer box and inner box is kept as it is. Similarly when new items are stacked at a location, then old items go below the newly arrived items.

To study difference between shelf life of different lots of same item at same location we selected a sample of 9 different items at 9 locations. The samples were selected such that age of items can be identified. All the items in sample were high value items. Date was found either by date of receipt given on tag attached with the lot, or date of manufacturing stamped on the item Results of sampling are given in tables 3.2(a) to 3.2(i).

Sample details:

Table 3.2(a): Observations for shelf life at DUNCAN; Item 1: 20-388-250 Electrode:

SL. No.	Shelf life
1.	1 packet of Feb. 92.
2.	1 packet of Aug. 92.
3.	5 packets of Oct 93.
4.	1 packets of Jan. 95.
5.	5 packets of Jan. 95.
6.	5 packets of Apr. 96.
7.	5 packets of May 96.

Table 3.2(b): Observations for shelf life at DUNCAN; Item 2: 20-264-315 Electrode:

SL. No.	Shelf Life
1.	3 packets of Feb. 92.
2.	7 packets of March 95.
3.	5 packets of June 96.

Table 3.2(c): Observations for shelf life at DUNCAN; Item 3: 20-264-500

SL. No.	Shelf Life
1.	10 packets of Jan 96.

Table 3.2(d): Observations for shelf life at DUNCAN; Item 4: 20-385-210

Receipt lot size	Actual present now	Mfg. date
20	3	Apr. 96
30	3	Apr. 96
16	3	May 95

Table 3.2(e): Observations for shelf life at DUNCAN; Item 5: 43-918-040 Chemicals

Sl. No.	Receipt lot size	Actual present now	Date of receipt
1.	5	3	Nov. 94
2.	4	4	June 96

Table 3.2(f): Observations for shelf life at DUNCAN; Item 6: 43-038-000

SL. No.	Received lot size	Actual present now	Date of receipt
1.	3	1	Feb. 91
2	10	10	Feb. 96

Table 3.2(g): Observations for shelf life at DUNCAN; Item 7: 65-301-002; Spare part

SL. No.	Actual Present
1	6 items of one lot are present. Total 51 items are present.

Lots received were as below:

22 items in Apr. 91

10 items in May 95

25 items in Apr. 95

So atleast 16 items of Apr. 91 are present.

Table 3.2(h): Observations for shelf life at DUNCAN; Item 8: 63-645-008

Sl. No.	Receipt lot size	Actual present now	Date of receipt
1.	4	4	Dec. 93
2.	10	3	July. 94

Table 3.2(i): Observations for shelf life at DUNCAN; Item 9: 60-550-045

Sl. No.	Receipt lot size	Actual present now	Date of receipt
1.	2	2	4 Feb. 94

In above samples, we observe that problem of different lots with more than 2 year difference in date of receipt is in Item no 1, 2, 6 and 7.

3.1.2.10 Error Due To Illegible Painted Code and Tag:

As mentioned earlier, chances of issuing wrong item exist if item is not properly identifiable. The item is identified either by the painted code on the item or by tag attached with the item. Persons doing physical verification are sometimes not able to identify the items even though it is present at the location.

- **Problem Of Illegible Painted Code:**

Items lying in the store for long time have problem of identification, because the painted code is not legible. This problem is more in case of big items lying in open yard. Manager store informed us that some times one motor is issued instead of other or one safety valve in place of other due to painted code being illegible.

- **Problem Of Illegible Tag Attached With The Item:**

The tags attached with items also have serious problem. Previously cloth tags were used but the code written on cloth was not legible after some time. Cloth is also susceptible to natural decay. Now metallic foil is used in place of cloth. But the code written on this is also not legible after some time.

- **Sampling For Percentage Of Illegible Painted Code:**

from study of one physical verification record, we observed that out of 25 items lying in yard, 15 items were having illegible code and people doing physical verification were not able to identify those parts.

- **Estimate Of Percentage Of Total Items Having Illegible Code:**

Person doing reconciliation estimated that 10-15% of total discrepancies are due to illegible code.

3.1.2.11 Sampling For Error due to manual counting:

We collected a sample in receiving area to get the idea of error due to manual counting. The results of sampling are given in table 3.3.

Table 3.3 Sampling for error in manual counting in DUNCAN

Sl. No.	Order number	Count Reported	Count Observed	Perc. Error
1.	ECC 1728	4	4	0%
2.	EJC 4134	12	12	0%
3.	ECC 2409	7	7	0%
4.	ECC 2049	35	35	0%
5.	ECC 2451	50	49	2%
6.	ECC 2792	12	12	0%
7.	ECC 1866	2	2	0%
8.	EJC 4775	5 set	5 set	0%
9.	ECC 1297	17 No.	17 No.	0%
10.	ECC 1271	20	20	0%
11.	60 550 103	6	6	0%

We observe that out of 11 items, the error is observed in only the item with large lot size.

3.2 TELCO:

We have categorised our observations for mismatch in this organisation with respect to:

I. Level of deviation between physical and computer stocks.

II. Observations for various practices and related errors in this organisation.

3.2.1 Level of deviation between physical and computer stocks:

For getting the estimate of percentage items with mismatch in stocks in this organisation we selected a random sample of 25 items and for these items data about physical and computer stocks was collected. The results of sampling are reproduced in table 3.4.

Table 3.4 Deviation Between Physical and Computer stocks in TELCO

Sl. No.	Part Number	Comp. Stock (CS)	Physical Stock (PS)	CS-PS
1.	3129953220	3792	Nil	3792
2.	206009134202	1289	197	1289
3.	257449104201	323	229	94
4.	12460500531	236000	106000	130000
5.	12460501057	156760	130750	26000
6.	0124920140	Nil	Nil	Nil
7.	3423220030	3865	1900	1965
8.	3523220530	7399	4700	2699
9.	16442800603	4150	1500	2650
10.	257630106705	5544	2800	2744
11.	100882010401	4679	3126	1553
12.	206035104206	4717	3530	1187
13.	206035104214	5071	3593	1478
14.	257332400119	7083	4350	2733
15.	206301173301	850	495	355
16.	907078000228	520	200	320
17	257349000101	707	300	407
18.	350588518207	45	45	Nil
19.	257349000102	300	200	100
20.	257449003322	1731	500	1231
21.	257332300112	813	544	269
22.	0429920020	Nil	Nil	Nil
23.	263026700101	547	60	487
24.	257354408203	600	400	200
25.	257450006301	1648	1150	498

There is error in 22 items out of total 25 items selected in sample. On the basis of above sample we estimate **percentage error as**=$\frac{22}{25}$ **X 100 = 88%.**

3.2.2 Observations For Various Practices And Related Errors In This Organisation:

Given below are some of the practices affecting mismatch in this organisation:

3.2.2.1. Mismatch Due To Quality Test Inspection:

The mismatches may get created due to sample drawn for quality testing due to following reasons:

I. For metallurgical testing the item is cut so it could not be returned. But the computer system does not consider this discrepancy i.e. no adjustment is made in the received quantity for the item undergone the destructive testing.

II. Parts taken by quality as sample for dimensional testing may not be kept back in lot.

For testing the validity of above reasons we took a sample of seven parts which had undergone the quality testing and had been okayed by quality. Big items were taken in this sample because there are chances of mismatch at the time of receiving for small parts. The observations of sample are given in table 3.5.

Table 3.5 Sampling for effect on mismatch of quality testing

Sl. No.	Part Number	Quantity Reported	Actual Quantity	Notes
1.	2574 4270 0138	53	53	Wt. around 3Kg. Can be counted easily
2	2573 4270 0156	60	58	Wt. around 0.5Kg. Suplied in a packing of 10 in a bundle. So can be counted very easily.
3.	2573 2900 148	100	99	Wt. around 400 gm. Can be stocked with a little difficulty.
4. 5. 6.	2060 3510 4207	28,24,24	27,23,23	Three packets were showing quantities 28, 24 and 24 respectively. Wt. around 500 gm.
7.	3505 8306 7703	125	121	

Quality provided us following information regarding quality test inspection of above items:

I. No sample is drawn for quality testing for item of sl. no.1.

II. One item is taken for metallurgical testing from each of the items of sl. no. 2 to 7.

III. Sample for dimensional testing is withdrawn for all the items of sl. no. 2 to 7.

3.2.2.2. Error Due To Manual Counting:

For collecting the error due to manual counting we studied items requiring manual counting in receipt section and issue store.

- **Observation in receipt section:**

We collected a sample of 4 items in receiving area which require manual counting for verifying the quantity. All these items were selected from the lots for which samples were not taken by quality. The results of sampling are given in table 3.6.

Table 3.6 Sampling for error due to manual counting in receiving area of TELCO.

Sl. No.	Part No.	Received on paper	Actual received	Notes
1.	2574 5420 8205	400	395	It was fully packed The packing was opened and quantity was verified.
2.	2060 8150 8201	466	461	
3.	2516 4900 7502	200	199	Shipped by supplier in bags of std. qty. 200.
4.	2632 4130 3304	39	38	

- **Observations in issue store:**

For big items error may take place at the time of keeping required number of items into bin due to manual counting. To estimate effect of this error on mismatch we selected two items of issue store for which manual counting is required at the time of bin preparation. The results of sampling are as given in tables 3.7(a) and 3.7(b).

Table 3.7(a) Sampling for error due to manual counting in issue store of TELCO: Part "E"

Sl. No.	Quantity written on tag	Actual Quantity in Bin
1.	55	49
2.	55	48
3.	54	50
4.	53	50

Table 3.7(b) Sampling for error due to manual counting in issue store of TELCO: Part "F"

Sl. No.	Quantity written on tag	Actual Quantity in Bin
1.	100	96

3.2.2.3. Sampling For Error Due To Human Judgement Of Quantity:

For each item quantity to be kept in bins for line feeding has been permanently fixed. The people in issue store are supposed to put this quantity in bins. They estimate the quantity subjectively for small items, as for small items like hardware items etc., it is not feasible to count number of items manually. To get the estimate of this error, we took a sample of 4 small items in which human perception of quantity is involved. We ourselves found the actual quantity present in bin with the help of electronic counter. The results of sampling are given in tables 3.8(a) to 3.8(d).

I. Table 3.8(a), Error due to human judgement of quantity in TELCO: Part "A" ;

Quantity written on tag	Actual Quantity in Bin
150	133
150	123

II. Table 3.8(b), Error due to human judgement of quantity in TELCO: Part "B" ;

Quantity written on tag	Actual Quantity in Bin
325	353

III. Table 3.8(c), Error due to human judgement of quantity in TELCO: Part "C" ;

Sl. No.	Quantity written on tag	Actual Quantity in Bin
1.	1000	953
2.	1000	893
3.	1000	823
4.	1000	875
5.	1000	929
6.	1000	883
7.	1000	949
8.	1000	855
9.	1000	949

IV. Table 3.8(d), Error due to human judgement of quantity in TELCO: Part "D" ;

Sl. No.	Quantity written on tag	Actual Quantity in Bin
1.	500	515

3.2.2.4. Error Due To Unauthorised Removal:

Error due to unauthorised removal was studied in following two sections:

I. Unauthorised removal in receipt store.

II. Unauthorised removal from rejection and scrap area.

a)Observations For Unauthorised removal in receipt section:

We observed that emergency issue procedure is not followed many a times and this is a major reason of deviation between physical and computer stock for the items which are generally under shortage. We studied three items under shortage to get an idea of error due to emergency issue. Following are the results of our study:

I. 352 331 0044 ; Rubber Buffer remains generally short of supply. It is brought almost daily. It's consumption is around 100 units per day.

585 units were stock adjusted on 24 Oct. 96.

Bin stock on 25/10/96 was of 25 units.

Uninspected stock is of 225 units.

Observation for uninspected stock for this item is given in table 3.9.

Table 3.9 Unauthorised removal of items in receiving area

GIN	Date of Receipt	Received Quantity	Actual Quantity Present	Diary Issue
1001/1/768	23/10/96	100	24	75 Diary issue on 24/10/96
1001/1/762	23/10/96	125	Nil	100 Diary issue on 25/10/96

So it seems that line feeders entered 100 quantity in diary issue and took away all 125 items in second case.

There was no item present in central material store. So just in one day after stock adjustment a shortage of 50 quantity is created due to emergency requirement.

II. 3010 0152 Assly. pull rod GIN 1101/2/5278 was received in 200 quantity. 50 quantity was entered in Diary issue but actually 125 units were present. So it seems that 50 units were entered in the record while actually three bags of 25 each i.e. 75 quantity were withdrawn.

We observed in our discussion with line feeders that the general psychology behind taking more items than entered in diary issue is that the line feeders want to be on safer side, so while taking items they also take into consideration the possible wastage on line.

III. 2577 3230 0103 Assly. Bkt. Shock Abs. RH GIN 1101/1/03066 of 24/10/96. Quantity received was 35 while physically present was 14 on 26/10/96. There was no diary issue for this item in this interval. This is a big item of wt. around 400 gm.

In summary we conclude that there is a major problem of unrecorded movement of material during emergency issue.

- **Observations For Unauthorised Removal Of Primary Rejected Item:**

We tried to get an estimate of items which were primarily rejected from quality but could not be found physically present in receiving area for storage in rejection store. Hence

"material not found" note was raised by quality. Four observations for such cases are shown in table 3.10.

Table 3.10 Unauthorised removal in items Primary rejected

GIN	Part Number	Qty. Rejected	Qty. physically Found
96/1101/1/2634	3505 8901 0129	50	21
10/97/1106/2/51	2574 4270 0138	300	Nil
10/97/1106/2/2094	2573 2910 0148	100	Nil
10/97/1106/2/2159	1060 0913 0112	96	Nil

Discrepancies like these were reported in around 100 items in first seven months of financial year of our study, which were primarily rejected by QA people. Per year there are around 5000 items primarily rejected.

b) Unauthorised Removal From Rejection And Scrap Area Stores:

Rejection and scrap area stores are unlocked and hence in these areas line feeders can come. Person in charge of rejection store informed us that about 25 times in a year, line feeders take material from rejection store without proper requisition. This is due to reason that item is under shortage on assembly line and it is lying in the rejection store.

Person in charge of scrap area informed us that there are around five cases of unauthorised removal by line feeders in a year

3.2.2.5. Observations For Error in record keeping during issue:

a) Error in system of entry into issue register:

I. In the earlier system of entry into register, there were some entries for which part number could not be traced. These entries were written as "PNP" i.e. part not present.

For getting an idea of extent of this problem we did a study of previous entries in issue register. Two random samples of 2360 and 800 entries each were selected. The results of sampling are given in table 3.11.

Table 3.11 PNP in entries of issue register in TELCO

Sample Number	Entries Studied	PNP	Transactions per PNP
1	2360	4	≈ 600
2	800	2	≈ 400

II. In the earlier system of entry into register of parts taken, there were some items which were not "PNP" but the people doing data entry had to do a major exercise in finding correct part number as the part numbers entered into issue resister was wrong.

For getting an idea of extent of this problem we again did a study of previous entries in issue register. Two random samples of 2360 and 800 entries each were selected. The results of sampling are shown in table 3.12.

We were informed that data entry operators write 31 against entries which are wrong and correct part number has to be found latter somehow. For finding the entries in which there was error of entering part code we found entries against which 31 was written by data entry operator or for which the code was changed by a different pen. This was due to the reason that if changes have been done by other pen, then it is more likely that previously wrong part number was entered and was corrected by someone else latter.

Table 3.12 Wrong Part number entries into issue register in TELCO

Sample Number	Entries studied	Error in entering part code by line feeder	Transactions per error of entry by line feeder
1	2360	81	≈40
2	800	33	≈24

b)Observations for error in bar coding system:

One of the major problems observed in the implementation of bar coded slip system is that, if a bin contains an incorrect-coded slip then at the time of issue a mismatch will be created and then there is no cross check available to correct the wrong entry in the computer record.

To get the estimate of mismatch due to this reason we did an inspection of 50 randomly selected locations from all over the store. We considered an error in bar coding system at

a location if one of following was observed:

1) No bar coded slip is there in the bin. This indicated removal of items without proper issue. We considered those bins also as the bins with slips in which card showing quantity and part code is lying instead of bar coded slip. This is because atleast it can be used for purpose of issuing.
2) Quantity in bin is different than quantity on bar coded slip.
3) Bar coded slip is of different item.

The results of sampling are given in table 3.13.

Table 3.13 Error in bar coded slip at a location

Locations studied	No slip	Wrong Quantity in Slip	Slip of Other item
50	8	6	3

3.2.2.6 Observations for shelf life:

In this organisation the location map is not available and at the time of withdrawal the location from where bin has to be picked is not specified. This creates problem of high shelf life, as the items are picked up randomly and not in FIFO order. For getting idea of shelf life we selected some rubber items on which date of manufacturing is stamped. The results of sampling given in tables 3.14(a) to 3.14(c).

I. Table 3.14(a) Shelf life for part number 312 291 1197 at TELCO

Quantity	Shelf Life
500	one month
500	four month
35	20 months
500	17 months

Average shelf life for this part is eight months.

II. Table 3.14(b) Shelf life for part number 265 2910 6307at TELCO

Quantity	Shelf Life
200	five months

III. Table 3.14(c) Shelf life for part number 1608 100 1000 at TELCO

Quantity	Shelf Life
600	five months and twenty days

3.2.2.7 Mismatches Due to Two Codes for the Same Item:

There are some items which have two different part numbers for two different suppliers. This problem is in all gauges like fuel gauge, pressure gauge, Amp. gauge etc. The reason of having two different part numbers for same item is, that these items are supplied by different suppliers. For these suppliers these items are standard items and the supliers provide only part numbers specific to him. So for the purpose of record keeping different part numbers are given to same part.

As the parts are same, so it is possible that people may pickup item of one company and give different part code of same part by other company in requisition. Due to this, discrepancy will get created in part number withdrawn and excess will be shown for part number of same item given in requisition.

To study the mismatch due to this reason we selected a sample of seven items for which two codes were possible. For these items we collected information about results of physical verification already carried out in second month of financial year under our study, from person who does physical verification round the year. The results of sampling are given in table 3.15.

Table 3.15 Mismatch due to two codes for same item in TELCO

Sl. No.		Part No.	Part Name	Physical Stock	Computer Stock	Difference
1.	a	2574 5420 9918	Fuel Gauge 12 V(P)	120	198	78(D)[1]
	b.	2574 5421 9992	Fuel Gauge 12 V(V)	520	436	84(E)[1]
2.	a.	2574 5420 9917	Amp. Gauge (P)	500	198	302(E)
	b.	2574 5421 9988	Amp. Gauge (V)	nil	381	381(D)
3.	a.	2574 5420 9919	Air Pr. Gauge(P)	552	380	172(E)
	b.	2574 5422 9908	Air Pr. Gauge(V)	400	540	140(D)
4.	a.	2574 5420 9917	Amp. Gauge(P)	540	318	222(E)
	b.	2574 5420 9988	Amp. Gauge(V)	800	962	162(D)
5.	a.	2573 4370 0108	Dual Break Valve	nil	210	210(D)
	b.	2573 4370 0144	Dual Break Valve	550	329	221(E)
6.	a.	2573 4370 0117	Air Brake Valve	500	802	302(D)
	b.	2573 4370 0124	Air Brake Valve	500	202	298(E)
7.	a.	2573 4310 0143	Unloader Valve	nil	160	160(D)
	b.	2573 4310 0122	Unloader Valve	250	114	136(E)

[1] (D) : Discrepancy in physical stock

3.2.2.8 Error due to wrong shipment:

It was reported that in a year there are about 90 cases of supplying different item by supplier than the part ordered Out of these in about 55 to 60 cases LH part comes in place of RH part and vice versa.

3.3 GEC:

We have discussed our observations for mismatch in this organisation with respect to:

I. Level of deviation between physical stock and computer stocks.

II. Observations for various practices and related errors in this organisation.

3.3.1 Level Of Deviation Between Physical And Computer Stocks:

3.3.1.1 Job Specific Items:

For the job specific items which are purchased/issued for a particular job only, there were no errors in two samples of 200 items each which we considered. On the basis of this we estimate that the **level of error in job specific items is nil.**

3.3.1.2 General Items:

For getting the idea of level of error in general items stored in main issue store, study of record of half yearly physical verification was carried out. Four samples of 48 items each were randomly selected from this record The number of items under excess or shortage, in each sample are shown in table 3.16

TABLE 3.16 Error in General items of GEC

Sample No.	Number of items under Excess	Number of items under Shortage	Total error	% Error (x)
1.	2	12	14	29.17%
2.	16	18	34	70.83%
3.	12	19	31	64.58%
4.	15	19	34	70.83%

For sample 1 error is on much lower side compare to other three samples. This may be due to the reason that certain items of this sample are standard and hence level of error is smaller.

For the above samples we estimate the average error as $\left[\frac{29.17+70.83+64.58+70.83}{4}\right]=58.85\%$.

Again as this data is for mismatch at the time of six monthly physical verification. Just after the physical verification the level of mismatch will become zero. So we can say that on average there will be error in $\frac{0+58.85}{2}=29.42\%$ items throughout the year.

We estimate that general items other than the job specific items, has mismatch in around 30% of items.

3.3.2 Observations For Various Practices And Related Errors In This Organisation:

Given below are some of the practices affecting mismatch in this organisation:

3.3.2.1 Error Due To Not Having Standardisation:

Hardware items are available in same diameter with a little difference in lengths. So one item can be used very easily in place of other item of a little different size. So some times the requisition is given for one part and item of near about same size is taken.

The store manager informed us that the reason behind having hardware items with a little difference in length for same diameter is because the transformer should be made as compact as possible. Less volume will save transformer oil which is very costly.

To study the error due to such a reason we selected three samples. In each sample items of same diameter but with a little difference in length were taken. For every sample we observed the difference in physical and computer stocks from half yearly physical verifications data. The results of our observations are as given in table 3.17.

Table 3.17 Sampling for non standardisation in GEC

Sample No.	Part No.	Part Description	Excess	Shortage	Deviation in Qty.
1	248124559	BTS clamping rod 24x3x550 mm long		√	6
	248124589	BTS clamping rod 24x3x580 mm long	√		4
	248124609	BTS clamping rod 24x3x600 mm long		√	2
	248124609	BTS clamping rod 24x3x610 mm long		√	5
	248124609	BTS clamping rod 24x3x620 mm long	√		3
	248124609	BTS clamping rod 24x3x630 mm long	√		12
	248124609	BTS clamping rod 24x3x640 mm long		√	1
	248124609	BTS clamping rod 24x3x650 mm long		√	8
2	247212109	BTS Stud 12x1.75x50 mm long		√	77
	247212139	BTS Stud 12x1.75x65 mm long	√		215
	247212149	BTS Stud 12x1.75x70 mm long		√	75
3	247212209	BTS Stud 12x1.75x100 mm long		√	23
	247212269	BTS Stud 12x1.75x130 mm long		√	102
	247212289	BTS Stud 12x1.75x140 mm long	√		139
	247212369	BTS Stud 12x1.75x180 mm long	√		10

3.3.2.2 Error Due To Different Sizes for Same item by Different Suppliers:

There are some items which are supplied in different sizes by different suppliers e.g. plates come in different sizes like 5'X3', 7'X2' etc. If issuing person does not measure the actual size of item issued then he may post the issue of different size in computer than actually taken. Due to this there will be deviation between physical and computer stocks.

3.3.2.3 Mismatch due to cutting:

During issue, due to cutting of items like copper strip etc. there is a special problem of mismatch. After cutting some small length is left which will be shown in computer stock but actually, it is not usable due to being very small in length. So it creates mismatch of the kind where item is physically present as per stock record but it is not usable.

3.3.2.4 Error Due To Cross Issue In Substitute Items:

Store manager informed us that mismatch is possible between items which can be used in place of each other. Two examples of this type of items are as below·

I. CT is a job specific item and all CT are kept at one place with part number written on it. Same CT can be used for two different jobs but material is received against a particular job only. Sometimes it happens that CT of one job has been used in other job.

II. Crap paper is both Indian and imported. So sometimes indigenous crap paper is withdrawn against requisition for imported crap paper and vice versa

3.3.2.5 Error due To Opening of Two Different Codes for Same Part:

If for same part two different codes are opened then requisition will be given for one code while actually other part code may be taken as both the items are same.

3.3.2.6 Mismatch Due to Wrong Code:

Production creates sometime by stating wrong code in requisition for job specific items. Some times the requisition are raised with part code corresponding to the jobs already completed, as the codes are same except for the job code. For example suppose one job of job number 1000 was made in January 96. For this job copper strip of part code XXXX1000X was issued 500 Kg. Other job of job number 1500 was made in November 96. For this job also copper strip of same size in 500 Kg is required. Part number for this job will be XXXX1500X.

Store people informed us that production sometimes raises RA with part number as previous i.e. XXXX1000X. So there will be a negative balance of 500 Kg in XXXX1000X and shortage of 500 Kg in XXXX1500X.

3.3.2.7 Error Due To Human Perception Of Quantity For Small Items:

For small items generally counting is not done. They are issued on the basis of perception of quantity. Due to this there may be mismatch for small items. One sample was collected for washers to get the extent of this problem. Results of sampling are as given in table 3.18.

Table 3.18 Error due to human judgement of quantity in GEC

Sl. No.	Code	Item	Comp. Stock	Phy. Stock	Excess Quantity	Shortage Quantity
1.	25320049	M.S. Plain punched washer M4	3310	3095		-215
2.	25320059	M.S. Plain punched washer M5	198	192		-6
3.	25320069	M.S. Plain punched washer M6	3800	3215		-585
4	25320109	M.S. Plain punched washer M10	3037	2694		-343
5.	25320129	M.S Plain punched washer M12	1535	1409		-126
6.	25320089	M.S. Plain punched washer M8	810	513		-297
7	25310089	Washer 21O/D, 10.5I/D	1942	1042		-893
8.	25310129	M.S. Plain punched washer M4	2931	2342		-589
9.	25310209	Washer 37O/D, 21I/D	2307	2219		-98

3.3.2.8. Error Due To Missing Of Item In Store:

We observed many times main issue store persons search for items present physically in store for more than half an hour. In the extreme cases stock out is shown for items physically present in store. We were informed by manager store that frequancy of these false stockouts are atleast once in a day.

3.3.2.9 Error Due To Duplication of RA:

In the case of emergency it may happens that two RA are raised for same item. Store persons informed us that item is issued to production once but both these RA are entered into computer due to which there will be deviation between physical and computer stocks.

3.3.2.10 Error Due To Unauthorised Removal:

Some times production takes item from store without giving proper requisition. If they fail to give requisition latter for item already taken then a mismatch will get created.

3.3.2.11 Error Due To Night Issue:

During night main issue store is open but store staff of very low hierarchy is present and is not familiar with location of storage of items. We observed that during night, generally production persons come inside the store to withdraw the item. The item withdrawn is recorded on a piece of paper and paper is kept by store staff present. Next day with the help of this paper, store prepares proper paper. One important reason of not raising RA in night is that on-line computer system is not available after 9 PM, on which RA is raised.

3.4 LML:

We have discussed our observations for mismatch in this organisation with respect to:

I. Level of deviation between physical stock and computer stock.

II. Observations for various practices and related error in this organisation.

3.4.1 Level Of Deviation Between Physical And Computer Stocks:

3.4.1.1 FIFO Section:

In this section storage system is random location system Locations are assigned with the help of computer to each lot received. At the time of retrieval location for withdrawal is specified by the computer.

Material handlers of FIFO section do physical verification for approximately four items per day and result of physical verification is maintained in a register. A sample of 150 entries of this register for FIFO items was taken at random and studied. There was no error in any item.

On the basis of this **we estimate the level of error in FIFO section as nil.**

3.4.1.2 NON-FIFO Section:

In the NON-FIFO section the system of storage is informal system. The material handlers of this section do physical verification of approximately four items under their

responsibility every day. Result of physical verification is maintained in a register. A sample of 100 entries of one such register was taken at random and entries were studied. There were mismatches in 8 items. On the basis of this sampling we estimate error to be in around 8% items of this section.

Estimate provided by the store manager were that deviation of more than 5% in quantity is observed in approximately 10% of the items.

On the basis of above observations our estimate of the error in items of NON-FIFO section is around 9%.

3.4.2 Observations For Various Practices And Related Errors In This Organisation.

Given below are some of the practices affecting mismatch in this organisation:

3.4.2.1 Error Due To Mismatch Of Location:

Stock handlers may place the bin at location other than its specified location as provided by the computer. Due to this, there may be some items which are not present as per the location shown in computer records. For this we studied two rows of FIFO section and studied the mismatch in locations. The results of our sampling are as below:

a) Observations in the 11th rack:

1. Location written on bin was x/x/22 but actual location was x/x/29.
2. Kept at location "Y", computer location "Z"
3. Kept at location "M", computer location "N".
4. Kept at location "A", computer location "B".
5. Kept at location "P", computer location "Q", written on bin location "R".
6. Kept at location "U", computer location "V".
7. Kept at location "C", computer location "D".
8. Kept at location "D", computer location "C".

b) Observations in the 10th rack

1. Kept at location "A", computer location "B".
2. Kept at location "C", computer location "D".
3. Kept at location "E", computer location "F".
4. Kept at location "F", computer location "E".
5. Kept at location "K", computer location "L".
6. Kept at location "L", computer location "M".
7. Kept at location "N" computer location "O".
8. Kept at location "P" computer location "Q".

There were total 231 locations in each rack

3.4.2.2 Error due to quality inspection:

For getting the idea of mismatch created due to destructive testing, we took a random sample for one item. This item was going to be stored in the FIFO section after quality inspection when we took sample. We noted quantity written on paper for this item as "Quantity Reported". We ourselves verified the actual quantity present in this lot and taken it as "Actual Quantity". The observation for this sample is given in table 3.19.

Table 3.19 Sample for Mismatch Due to Destructive Testing in LML

Part No.	Quantity Reported	Actual Quantity	Deviation
C-270984	90	89	1

It was further informed that store will get requisition for item used in destructive testing latter from quality and will be shown as "Quality consumed". But we observed that in existing list of stock of items the stocks are in round figures like 100, 150, 200 etc. and entries like 99,148,198 etc. could not be observed, indicating that entries for quality testings are not made.

3.4.2.3 Error Due To Wrong Shipment By Supplier:

About 100 such cases were reported during first eight months of the year.

3.4.2.4 Error Due To Unauthorised Removal:

During one week of our study one case of unauthorised removal by production from receiving store was noted.

3.4.2.5 Observations For Error Due To Manual Counting:

For getting an estimation of error due to manual counting we did sampling in receiving area and results of the sampling are given in table 3.20.

Table 3.20 Sample for Error due to manual counting in LML

Sl. No.	Code No.	Qty. per bundle	Actual Qty. 1. 2. 3. 4.				Note
1.	C-1707164	25 per bundle	25				Big part
2	C-0712547	5 per bundle	5	5	5	5	Big part
3.	C-4709813	10 per bundle	10	10	10	10	Medium sized part. Wt. around 200gm.
4.	216740	5 per bundle	5	5	5	5	Medium sized part. Wt. around 300gm.
5.	C-0712547	10 per bundle	10	10	10	10	Big part

We were further informed by manager store that around one case per thousand of mismatch in quantity during receipt is reported.

3.4.2.6 Error Due To Manual Entry Of Data:

I. As the production plan for next day is sent to store on paper and not on the on-line Computer system, there are chances of error of data entry. Although the stock handlers could not give us any assessment of error due to manual entry but all of them accepted that some times they make wrong entry of part number and quantity which they correct latter.

II. There were cases of showing issue of the component to a place where it can not be used. There were 4 such cases in the month of Oct.

3.4.2.7 Observations For Shelf Life:

We observed five items of FIFO area for the shelf life and our observations are shown in table 3.21.

Table 3.21 Shelf life in FIFO section for LML

Part No.	Quantity	Shelf life	Average Shelf Life
1372607	13000	2 months 11 days	29 days
	29000	1 month 5 days	
	20000	28 days	
	15000	25 days	
	19000	20 days	
	13000	11 days	
177442	1144	1 months 8 days	19 days
	3808	18 days	
	10080	18 days	
	10080	18 days	
194423	2000	1 months 17 days	16 days
	8000	26 days	
	12500	6 days	
	250	6 days	
196230	1550	1 months 11 days	one month
	800	1 month 8 days	
	1600	1 month 5 days	
	1600	1 month	
	900	1 month	
	1600	1 month 21 days	
	1400	1 month 21 days	
90541	1550	1 months 20 days	16 days
	5000	28 days	
	400	28 days	
	5000	8 days	
	5000	8 days	
	5000	8 days	

4

FACTORS INFLUENCING THE MISMATCH

Mismatch between physical stock and record stock (computer stock) is likely to be created due to one of the following three reasons:

a)Human induced error.

b)Error caused due to improper procedures.

c)Error caused due to poor record keeping instruments such as unidentifiable tags, numbering on the locations, requisition forms etc.

Further error can be reduced by better control mechanisms such as access to store, physical verification and computerisation etc.

There will be some factors which will increase the chances of mismatch. Similarly there will be some other controlling factors which if present will reduce the chances of mismatch. A better understanding of these factors will help us in designing better warehousing system and control procedures to reduce mismatches. In this chapter we have identified factors which are likely to influence mismatch and analysed the impact of these factors based on the data and information collected from the four organisations we studied.

Factors affecting mismatch:

On the basis of observations made in organisations, we identified following factors which are likely to have influence on the mismatch:

1. Product structure.
2. Computerisation.
3. Physical verification system.
4. System of storage of items.
5. Quality inspection policy.
6. Access to store.
7. Issue system.
8. Measurement error.

9. Coding system.

Initially we considered some other factors also, which may have influence on the mismatch. However we were not able to collect any specific data to verify their impact on mismatch. These factors are as below:

1) Organisational structure: If production is also responsible for keeping a record of items withdrawn from store Then this may help in reducing unauthorised removal by production from store.

2) Manpower: If adequate manpower will not be provided then the chances of mismatch will be higher.

3) Motivation of the employees: If warehouse personnel give importance to keeping accurate record of inventory in store, then mismatch can be reduced.

In the following sections we will analyse the impact of each of the nine factors.

4.1 PRODUCT STRUCTURE :

Physical shape, size, similarity of product, nature of their usage and other similar characteristics are likely to influence warehouse practices. Product structure identifies the various characteristics of material stored in a warehouse. We identified the following components of product structure, which are likely to have impact on mismatches:

1. Level of standardisation.
2. Job specific items.
3. Use of item.

4.1.1 Level of Standardisation :

Standardisation is to keep number of items in bill of material as small as possible. Standardisation can be done in many ways. One way will be to remove subassemblies from bill of material and introducing assembly of these subassemblies in bill of material. Before standardisation subassemblies were purchased, stored and assembled to make assembly. It was

observed in TELCO that over the year they have reduced the level in bill of materials by directly procuring the assemblies from the supplier.

The reduction in bill of material can also be achieved by standardising different specification items in bill of material by single item as far as possible. This is effected by redesigning the item after taking into consideration the feasibility of using standard item.

A large number of similar products are likely to create mismatches due to identification problems. We have analysed the influence of this factor in the next subsection:

4.1.1.1 Basis:

Due to non standardisation there will exist items of near about same size. As one item can be used in place of other item so it will happen that people will give requisition for one item and they will take other item of near about same size which can be used in place of item for which requisition was given. Due to this reason there will be excess in physical stock compared to computer stock for the item for which requisition was raised This is because, entry in the computer will be made for the item requisitioned. So the computer stock for this item will reduce by the amount given in requisition. While physically this item has not been issued. Similarly there will be shortage in physical stock compared to computer stock for the item actually withdrawn This is because in computer no issue will be entered for this item, and hence computer stock for this item will not reduce. As physically this item has been taken, the physical stock will get reduced by the amount given in requisition. So in the case of items which can be used in place of other items, if physical stock for an item is more than its computer record, then we can conclude that due to items being similar, requisition has been given for one item, while physically other item has been picked up.

4.1.1.2 Observations:

4.1.1.2.1 GEC :

In GEC, for the general category of items which are not job specific, level of standardisation is very poor. Items like bolts are available at 5 mm difference in length for same diameter. Bolts of near about same length and of same diameter could be used very easily in place of each other. It is observed that very often while on paper requisition is given for one item, some other similar item is picked up.

Study of effect on mismatch due to non standardisation in this company was done in following two ways:

1. Study of mismatch in items of similar size to observe the effect of non standardisation on mismatch.
2. Sampling from a store having non standardised items, to get approximate level of mismatch in the items of this store due to non standardisation.

4.1.1.2.1.1 Results of Sampling for Mismatch in Items of Similar Size:

To get the idea of error due to non standardisation, three samples were randomly selected from half yearly physical verification data. In each of the three samples items of same diameter with a little difference in length were taken and deviation between physical and computer stocks was recorded. The result of sampling has been shown in table 3.17. The summary of results of table 3.17 is shown in table 4.1.

Table 4.1 Summary observations for mismatch due to similarity of items

Sample No.	Total Excess Quantity	Total Shortage Quantity
Sample 1	19	22
Sample 2	215	152
Sample 3	149	125

In each of the three samples above, excess amount is almost equal to shortage. The likely reason of this kind of deviation is that requisitions were given for items which is in excess while actually similar items under shortage were picked up. This error can be assigned to the lack of standardisation.

As the deviations in the above samples is also due to taking item without giving requisition , error due to manual judgement of quantity for small items instead of actually counting the quantity (specially applicable for sample 2) etc., in addition to error due to non standardisation, there is some deviation between excess and shortage quantities.

4.1.1.2.1.2 Study Of Mismatch In Items Of Store With Non Standardised Items:

To get an idea of percentage of total items of store in which deviation will be due to

non standardisation, we studied the items of main issue store, because in this store many items stored are non standardised. In this case 4 samples of 48 different items each were randomly selected from the data of half yearly physical verification for this store In each sample items taken are of near about same size. The results of sampling are given in table 3 16.

An excess is likely to get created due to giving requisition for one item but picking up a similar item. As most of the other reasons for mismatches are likely to cause shortage of items, we inferred that the excess is caused by the pickup of similar items. As each such excess will cause shortage in atleast one other item, we can assume that total number of items in which the error is caused due to non standardisation is between number of items having excess and twice the number of items showing excess. So we can break the total error observed in samples of table 3.16 in two components. First component of error may be considered due to non standardisation and second component can be taken as error due to reasons other than non standardisation. The break up of total error from the sample data in table 3.16 is show for these two components in table 4.2

Table 4.2 Error due to non standardisation in GEC

Sample. No.*	Upper limit for Error due to non standardisation (2 × Excess)	Minimum Error due to other reasons	Max. % items of the sample under error due to non standardisation (x)
1.	4	10	8.3
2.	32	2	66.7
3.	24	7	50
4.	30	4	62.5

(Note *: Sample size = 48)

Max. percentage of item of the sample having error due to non-standardisation

$$= \frac{\text{Upper Limit for error due to non-standardisation}}{\text{Sample size}} \times 100$$

For sample 1 error is on much lower side compare to other three samples. This may be due to the reason that certain items are standard in this sample.

Average percentage of items of the sample having error due to non-standardisation $(\bar{x})$ =46.9%.

On the basis of above sample we estimate the error due to non standardisation in 46.9% items.

This data is for mismatch at the time of six monthly physical verification. Just after the physical verification the level of mismatch will become zero So we estimate that on average there will be error in $\frac{0+46.9}{2}$ = 23.4% items throughout the year.

Thus we estimate an upper limit of 23.4% items (average over the year) will have error due to non standardisation.

4.1.1.2.2 DUNCAN :

In DUNCAN level of standardisation is much better than GEC. Previously the number of items stored were around 60000 but now the number of items have come down to around 40000. But there are still some items which can be used in place of each other. Due to this non standardisation, there are mismatches in these items similar to the case of GEC (refer 3.1.2.7). One typical example of error due to non standardisation in this company is as below :

Paint brush are available in different sizes in store. Paint brush of 2" size was showing nil physical stock, but computer stock was showing (-85) i.e negative eighty five balance. This is likely to be due to requisition being given for paint brush of 2" size, but actually some other brush of near about same size being issued.

Person responsible for reconciliation reported that out of total discrepancies reported by physical verifiers there are 15-20% items in which error is due to issue of similar item against a requisition. As there is total deviation in around 10% of the items (refer to 3 1.1.1), the estimated size of mismatch is around 1.5% to 2.0% of all the items due to non standardisation.

4.1.1.2.3 TELCO:

In this company level of standardisation is much better than both GEC and DUNCAN. As per the persons on assembly line, no case of supplying item other than required one has been observed.

In summary we conclude; standardisation has considerable impact on the mismatches. In the organisations with the higher level of standardisation the mismatch errors are much less compared to the organisations with lesser level of standardisation.

4.1.2 JOB SPECIFIC ITEMS :

For the customised product, design will be done after knowing the requirements of the customer. So there will be some components which will be purchased only after getting the requirement of customer. These components can be issued only for manufacturing of particular job for which it was purchased. These items will be called job specific items. These job specific items are reserved for one particular job only

4.1.2.1 Basis:

As the job specific items can be issued for a particular job only, they are issued only when manufacturing of that particular job starts. Due to requirements of different customers being different, generally items purchased for one job can not be used in other jobs. If the job has been completed, and if any item purchased for this job is showing some stock in computer records, then it can be easily detected that there has been an error between physical and computer stocks. This is due to the reason that without using every job specific item purchased for this job, the job could not have been completed. So after this error is detected, computer stock for that job specific item can be adjusted. So the detection of error in job specific items is very easy.

4.1.2.2 Observation:

To study the impact of job specific items on the problem of mismatch between physical and computer stocks we observed the level of mismatche for job specific items.

In GEC the product is customised product. For every transformer different customers have different requirements. So after getting an order according to customer requirements they purchase items. So these items will become job specific items and they could be issued only for the job for which they were purchased. In these job specific items there is almost no error between physical and computer stocks (refer to 3.3.1.1).

In summary we conclude that; job specific items are likely to report mismatches only due to record keeping errors and hence after the job is completed a reconciliation will help in removing this mismatch.

4.1.3 END USE OF ITEMS:

This gives us an idea that how the material will be consumed. The end uses of items present in warehouses under our study are as below:

I For making a standard design product. Standard design product is that whose design is fix. This was case in TELCO and LML.

II. For making a customised non standard product as was in the case of GEC.

III. Indirect material such as maintenance parts. This was the case in DUNCAN.

Only observation we were able to make for this subfactor was with respect to wrong shipment by the supplier. we analyse this problem in next section.

4.1.3.1 Mismatched Shipment at Receiving:

In some of the cases it is observed that item supplied by supplier physically is different than the item supplied on paper with the lot. This will be treated as mismatched shipment at the time of receiving.

4.1.3.2 Observations:

4.1.3.2.1 TELCO:

In a year about 90 cases are observed, where part supplied are different than the part indented. In this there are 55 to 60 cases in which LH parts come in place of RH and vice versa.

4.1.3.2.2 LML:

Around 100 such cases were reported during first 8 months of this financial year under observation.

4.1.3.2.3 DUNCAN and GEC:

No case of supply of items not indented were reported for these two companies.

4.1.3.3 Basis:

On the basis of above observation we find that there is problem in the case of standard design product(refer to 4.1.3). While this is not a problem in customised product(GEC) and maintenance parts(DUNCAN). The likely reasons of this are as below:

a) Some suppliers have a tendency to supply part other than for which order was given to them to supply. They try to get payment latter by showing receipt of this wrong material into store.[Tersine(1977)] In the case of standard design product one supplier is generally supplying more than one item frequently. In case he supplies a wrong item it is likely to be accepted as their will be requirement for this part also. While in the case of customised product most of the items are job specific so no other item will be accepted in place of item required. For the maintenance components generally consumption of an item is low. So if other item has been received. Then this additional item will cause build up of inventory, and hence chances of getting such item accepted are low

b) Further in the case of standard design product the supplier starts production after getting order from company. As the drawing for LH and RH parts are same, so if there is any error in communicating to shop floor the LH part will be produced in

place of RH and vice versa. So while supplying the item to company paper will be for RH component while physically the LH component will go and vice versa.

In TELCO the vehicles produced are generally for Left Hand Drive(LHD) condition which is as per Indian traffic rules But there is also some production for export. For export to some of the foreign countries the vehicles produced are Right Hand Drive Condition (RHD) due to their traffic rules. Some components for LHD and RHD vehicles are mirror image of each other. as generally the production of LHD vehicles take place so the people at shop floor of supplier are producing components of LHD vehicles most of the time. For the order of RHD vehicles if people at shop floor of supplier are not specially instructed then they will produce part of LHD again. There are at least 5 such cases in a year in TELCO.

Mismatch due to wrong shipment at receiving:

It was observed that for standard design product the general practice is not to return the item wrongly received to supplier. Instead of returning the item new requisitions for wrongly received shipment are obtained from supplier. Hence this process takes some time. In this interval as the item is physically lying in store, sometime it is withdrawn by production. But this withdrawal can not be entered into computer because receipt of this item has not been entered. When correct papers are received from supplier then while computer stock is updated but the issue which already has taken place are not entered. Due to this a mismatch will get created between physical and computer stocks.

In summary we observe that in the organisations where same items are continuously received, there are more chances of wrong supply being made, as likelihood of such items being accepted are high. In such case discrepancy between physical and computer stock get created due to delay in appropriate paper work.

4.2 COMPUTERISATION :

The computer can be integrated with the physical operations of the warehouse to assist warehouse employees in their operations of: [Tompkins(1988)]

I. Receiving material into the warehouse and updating inventory records.

II. Inspection and quality control of inbound materials to ensure that proper quality and quantity of material are received.

III. Storage and location of material. Determination of the location of material and maintaining proper inventory records.

IV. Cycle counts of inventory to ensure accuracy of inventory and location records.

V. Order entry and preparation of proper packing documents and shipping levels.

VI. Scheduling of work in the warehouse using standards for each operation.

VII. Replenishment of forward picking lines, if appropriate, for the physical operation of the facility.

VIII. Inspection of customer or end user shipment for accuracy.

IX. Scheduling of outbound delivery vehicles or common carriers.

X. Development of load plans for outbound shipments.

4.2.1 Observations For Computerisation In Organisations Under Study:

First we categorised the type of activities and the level of computerisation for each of the category. This we used to subjectively estimate the level of computerisation of different organisations.

4.2.1.1 Categorisation Of Activities:

We have identified computer related activities into two categories:

I. Input and data entry.

II. Reports and refusals.

4.2.1.1.1 Input and Data entry:

Table 4.3 summarises the input and data entry activities for each of the four organisation. A √ implies that activity is being done by computer in that organisation.

Table 4.3 Status of different record entries by computer

Entry	TELCO	DUNCAN	GEC	LML
Entry at the time of receiving	√	√	√	√
Entry after quality testing	√		√	√
Entry of receipt of item into store			√	√
Giving location of storage by computer				√*1
Raising requisition on computer			√	
Entry into computer of issue	√	√	√	√
Entry into computer of emergency issue				√
Location map		√*2		√*1
Search of location of withdrawal at the time of issue		√*2		√*1

(Notes : 1. √*1 is only for FIFO section ;

2. √*2 is with the help of location cards and not by computer.)

4.2.1.1.2 Output reports and refusal list:

We briefly outline major output reports produced using computer in various organisations below

I. DUNCAN:

- At the end of every month list of items having negative balance is prepared.
- List of stockouts is prepared by computer.

II. GEC :

- At the end of every month list of items having negative balance is prepared.
- List of slow moving and non moving items is prepared at the end of every month.
- Computer is used for placing order for common consumable items to get consumption pattern.
- List of items under shortage is given by computer.

III. LML:

- At the end of every month a list of items issued to production and standard consumption of that part is prepared.
- A report of slow moving and non moving items can be obtained through computer
- A list of negative balance is raised every day.

4.2.2 Assessment of level of computerisation:

On the basis of use of computer subjective assessment of the level of computerisation in different organisations is made as below:

I. TELCO:

Except for entry of receipt and issue, computer is not used for any other purpose (refer to 4.2.1.1). We assess the level of computerisation in this organisation as "Low".

II. DUNCAN:

Report of slow and non moving items is not prepared due to which problem of high shelf life is arising. Requisition is not raised on computer Location map is not available on computer, but it is available on cards which is fulfilling the requirement. We assess level of computerisation in this organisation as "Medium".

III. GEC:

Computer is used for raising requisition, items under emergency requirement, list of slow and non moving items etc. Location map is neither available on computer nor on cards. We assess the level of computerisation for this organisation as "Medium".

IV. LML:

Two different levels of computerisation are existing in this organisation. The level of computerisation in FIFO section is much higher than in NON-FIFO section.

Now we will subjectively assess the level of computerisation in FIFO and NON-FIFO sections for this organisation.

a) **FIFO section of LML:**

In this area computer is used for every activity except raising requisition by production on computer. On the basis of this we assess the level of computerisation in this organisation as "Very High".

b) **Non-FIFO section of LML:**

For non FIFO items computer is used for all activities except search for location of item being withdrawn, as there is no location map available in computer for this section. However items are assigned to specific person in the store and the same person is responsible for the issue and receipt of that item. Also the number of items under each person are around 350 only and most of these items are moved regularly so there is not much problem due to not having location map. Production people are not raising requisition on computer but they are giving requirements one day in advance on a printed format So most of the problems arising due to not raising requisition on computer like illegible entry, wrong part code given in requisition etc. are taken care of. Only error possible is error during entry of item code and quantity issued into computer by store personnel Considering these points we assess level of computerisation for this section in this organisation as "High".

4.2.3 Impact of Computerisation :

We observed impact of computerisation on mismatch with respect to:

I. The level of computerisation and overall error.

II. The level of computerisation and shelf life

We analyse the impact in the same order in following sub-sections.

4.2.3.1 The Level of Computerisation and Overall Error:

We will compare the level of computerisation and overall level of error in different organisations to study the effect of computerisation on mismatch. This comparison seems logical because computerisation improves the performance of overall system and overall level of mismatch gives us an idea of effectiveness of overall system. Table 4.4 provides summary of observations for this comparision.

Table 4.4 Comparison of Level of Computerisation and Mismatches.

Organisation	Level of computerisation	Percentage Mismatch*
TELCO	Low	88%
DUNCAN	Medium	10%
GEC	Medium	30%
LML (non FIFO)	High	9%
LML (FIFO)	Very High	0%

(* for percentage mismatch refer to sections 3.2.1,3.1.1.1,3.3.1.2,3 4.1.2 and 3.4.1.1 respectively)

From the table 4 4 we get a general trend that as the level of computerisation is increasing level of mismatch is reducing. However there are some other factors also which are affecting the level of error For example in DUNCAN the level of error is same as the level of error in LML for non FIFO items. This is due to higher physical verification in the case of DUNCAN. Similarly the level of computerisation is same in DUNCAN and GEC but level of error in GEC is much higher due to non standardisation.

4.2.3.2 The level of computerisation and shelf life:

Another kind of mismatch observed is, while item is physically available and is recorded in the computer stock, it is not usable. This is basically due to high shelf life of items. Computerisation can help in keeping track of shelf life and the location of different lots of the same item. Then by following the policy of FIFO, shelf life can be reduced. We analys the effect of computerisation on error of this kind, in next sub-section.

We have compared level of computerisation and shelf life of GEC and DUNCAN because in both of these cases demand of item is probabilistic (not known in advance) and there is no regular consumption of items. Also batch size is generally small for these organisations. Similarly we have compared shelf life in the case of LML and TELCO because demand for items is known in advance by production plan. Batch size during issue and receipt is also high for these organisations.

4.2.3.2.1 Comparison of computerisation and shelf life between GEC and DUNCAN:

In GEC a list of slow moving and non moving components is prepared at the end of every month by computer while there is no such report in the case of DUNCAN. The problem of items being obsolete due to high shelf life is negligible in the case of GEC (less than 5 items in a year become obsolete due to this reason). While the high shelf life is a very big problem for items in the case of DUNCAN (refer to 3.1.2.8).

4.2.3.2.21 Comparison of computerisation and shelf life between LML and TELCO:

In the case of LML a report of slow moving items can be obtained on computer any time(refer to 3.4.4.1.2.3). While there is no such facility available in computer system of TELCO. High shelf life is creating problem in TELCO, specially for rubber items.

For getting the idea of shelf life of items in LML we selected FIFO items because in this section lots with different arrival dates are stored in different bins instead of being mixed. For our sample we noted the date of receipt of the items. This provided us an opportunity to consider impact on shelf life for the organisation with "Very High" category of computerisation. The observations for shelf life are shown in table 4.5 (refer to 3 4.2.7)

Table 4.5 Average Shelf Life in LML

Sl. No.	Part no.	Average Shelf Life
1.	1372607	29 days
2.	177442	19 days
3	194423	16 days
4.	196230	30 days
5.	90541	16 days

On the basis of these observations the average shelf life is estimated to be 22 days.

For getting the idea of shelf life of items in TELCO we selected rubber items, because while different lots are mixed together for these parts, date of manufacturing is stamped on these parts.

The results of observations for shelf life are shown in table 4.6 for TELCO. (refer to 3.2.2.6):

Table 4.6 Average Shelf Life in case of TELCO

Sl. No.	Part no.	Average Shelf Life
1.	3122911197	8 months
2.	26529106307	5 months
3.	16081001000	5 months 20 days

At the time of taking observations the average shelf life was around 6 months.

We observe that for the organisations where level of computerisation is high and where computer system is used to provide a report of slow moving and non moving parts, the average shelf life was low(22 days for LML). While the case in which level of computerisation is poor and also no report of slow moving and non moving parts can be obtained from computer system the average shelf life was much higher (around 6 months for TELCO).

We can conclude that effective computerisation is highly useful in reducing shelf life of items.

In summary we conclude that higher level of computerisation improves record keeping and hence chances of mismatches between physical and computer stocks reduces considerably. Further it reduces shelf life of items due to better control.

4.3 PHYSICAL VERIFICATION SYSTEM:

A physical count of items is necessary to verify the integrity and accuracy of inventory records. Difference between book (record) and physical inventories must be ascertained. Any difference (variances) must be adjusted and amount of overage or underage properly accounted for. There are two methods of physical verification : [Tersine(1977)]

4.3.1 Periodic Count method:

The periodic count method refers to the periodic auditing of the inventory balance on hand to verify and maintain accurate inventory records. The periodic count method requires a

complete count of all categories of inventory over a short period.

The frequency of taking physical inventory is often determined by the value, criticality and the ease of disposing of the item in open market. Expensive or precious items may be inventoried much more frequently than general inventory items.

4.3.2 Cycle Count Method:

This method requires continuous counting of stock throughout the year. A limited number of items are checked every day or on some other time interval. Personnel can be assigned to cycle count on a full time or part time basis. The stock items to be checked may be selected at random or according to a predetermined plan. Of course, the cycle count method does not require a disruptive termination of operations as the periodic count method does.

The cycle count method is becoming more widely used by organisations as it permits the use of specialists or regular assigned store personnel to conduct physical verification. When regularly assigned store personnel are utilised they can perform cycle count during lulls in their assigned duties. When specialists are used, they are full time personnel who continually count inventory items. In large organisations specialists are desirable, since they become familiar with items, the locator system, the storage system and "particular" things that can occur.

Several procedures have been developed to vary the cycle count frequency Some of more prevalent systems are as follows:

I. **ABC systems:** Highest frequency on "A" class and least on "C" class items.
II. **Reorder system**: Count items at the time of reorder.
III. **Receiver system**: Count items when replenishment order is received
IV. **Zero Balance system**: count items when balance on hand is zero or negative.
V. **Transaction system**: Count items after a specific number of transactions have transpired.

Cycle count method is an excellent method of maintaining record accuracy. Some of the more apparent advantages are as below:

I. Inventory counts are not performed under pressure, this usually results in more accurate measurements. One has a correct statement of assets throughout the year.

II. Specialists become efficient in obtaining good counts, reconciling differences and finding solutions for systematic errors.

4.3.3 Physical Verification System In Organisations Of Our Study :

We found in our study that all the four organisations are having some system of physical verification to adjust the deviations between physical and computer stocks. The system of physical verification in each organisation of our study is discussed below:

4.3.3.1 TELCO :

There is system of annual verification which is a "Periodic count method" with one year interval between two physical verifications. In addition when the item goes under shortage then the physical and computer stocks are generally tallied to show zero balance in both the stocks This can be treated as "Cycle Count Method" and procedure adopted for cycle counting is "Zero Balance". Stock is adjusted in this way for approximately 10 items each day. Discrepancies found are adjusted by showing issue of item to the production line and no analysis for reason of discrepancy is carried out

4.3.3.2 DUNCAN :

Round the year there is physical verification of items which is "Cycle Count Method" with procedure adopted for selection of item as "random selection of items". Physical verification is done with the help of specialists. There is no system of periodic verification. In first six months of this financial year of this study there were 12720 items physically verified. Store manager reported that in a year physical verification of approximately 33000 items is carried out. Reasons of error for every discrepancy are found out.

4.3.3.3 GEC:

There is system of half yearly physical verification of items in main issue store which are mostly "C" class items. So they are using "Periodic Count Method" with difference of six months between two physical verifications. The reason of every discrepancy is found out.

4.3.3.4 LML:

There is system of half yearly physical verification. So they are using "Periodic Count Method" with difference of six months between two physical verifications. The stock handlers

of store also do physical verification of approximately 4 items out of items assigned to them daily. This is "Cycle Count Method" with "random selection" of items for doing physical verification. The cycle count is performed without the help of specialists Only the regularly assigned store personnel are utilised to perform cycle counting during lull of their assigned duties. For FIFO items, when during issue zero balance is shown in computer stock after withdrawal of items from a location, then stock is physically verified after withdrawal. The reason for every discrepancy is found out in this company.

4.3.4 Relationship Between Physical Verification and Inventory Accuracy:

It seems logical that higher will be the level physical verification higher will be the level of inventory accuracy. Young(1991) developed the relationship between physical verification and inventory accuracy in the case of cycle count method We reproduce it in section 4.3.4.1 We developed a similar relationship for the periodic count method as described in section 4.3.4.2.

4.3.4.1 Cycle Count Method:[Young(1991)]

Suppose we have a system in which there are n_{mh} material handlers. Each material handler performs n_{tr} transactions every day. Let the probability of committing error which will create deviation between physical and computer stocks is "p" per transaction.[Young(1991)]

Number of transactions in a day= $n_{mh} \times n_{tr} = n$

Let us assume that there are N_{pv} people doing physical verification every day and they are verifying N_{lo} locations every day.

So number of locations verified every day = $N_{pv} \times N_{lo} = N$

If inventory accuracy of items in store is IA then number of errors corrected by people doing physical verification every day = N(1-IA).

Rest N.IA locations will be already correct.

Inventory accuracy of items in store IA=

$$\frac{\text{locations / items for which there is no deviation between physical and computer stocks}}{\text{Total locations / items in the store}}$$

Also the error inserted into new items per day = p.n.IA.

The rest error p.n.(1-IA) will be created in items in which there is already error.

There will come a condition of equilibrium, when errors introduced in new items per day will become equal to number of errors corrected by physical verifiers per day. In this case value of IA will get stabilised.

So at equilibrium p.n.IA = N(1-IA)

$$\frac{n}{N} = \frac{(1 - IA)}{p.IA} = \frac{1}{p}\left(\frac{1}{IA} - 1\right)$$

$$\textbf{So IA} = \frac{1}{\left(1 + p.\frac{n}{N}\right)}$$

So smaller will be the "p" i.e. probability of error per transaction higher will be IA.

Similarly smaller will be $\frac{n}{N}$; i.e. higher physical verification per transaction higher will be IA.

As "p" depends more or less on system properties like access to store, product structure, level of standardisation, storage system, quality policy system of issue, coding system etc. and hence can not be controlled very easily. Hence for increasing IA one effective method will be to increase physical verification per transaction.

In deriving the above results following assumptions were made:

I. The error due to transaction is randomly distributed in items.
II. The probability of error per transaction is static and not dynamic.
III. There is no other way to correct mismatches except by people doing physical verification.
IV. Locations selected for physical verification are random.
V. People doing physical verification makes no error.

4.3.4.2 Periodic count method:

We have assumed that just after doing periodic count, level of error is zero.

Suppose we have a system in which there are n_{mh} material handlers. Each material handler performs n_{tr} transactions every day. Let the probability of committing error which will create deviation between physical and computer stocks is "p" per transaction.

Number of transactions in a day= $n_{mh} \times n_{tr} = n$

Errors inserted in new items due to transactions in first day = p.n.

If total items in store are M then

$$\text{IA on 1st day} = \frac{M - p \times n}{M} = 1 - \frac{p \times n}{M}$$

Error inserted in new items due to transactions on 2nd day = p×n×IA of 1st day

$$= p \times n \times \left(1 - \frac{p \times n}{M}\right)$$

So fraction of total new items present in store which went wrong on second day=

$$\frac{p \times n \times \left(1 - \frac{p \times n}{M}\right)}{M}$$

So IA on 2nd day = IA on 1st day - fraction of total new items in which error created on 2nd day

$$= \left(1 - \frac{p \times n}{M}\right) - \frac{p \times n \times \left(1 - \frac{p \times n}{M}\right)}{M}$$

$$= \left(1 - \frac{p \times n}{M}\right)\left(1 - \frac{p \times n}{M}\right)$$

IA on Rth day = IA_r

Error created in new items due to transaction on (r+1)th day = p.n IAr

So fraction of total new items in which error was created on (r+1) th day =

$$\frac{p \times n \times IA_r}{M}$$

So IA on (r+1) th day = IA on R th day - fraction of total new items in which error created on (R+1) th day

$$= IA_r - \frac{p \times n \times IA_r}{M}$$

$$= IA_r\left(1 - \frac{p \times n}{M}\right)$$

$$\text{IA on 1 st day } IA_1 = \left(1 - \frac{p \times n}{M}\right)$$

So IA on R th day $= \left(1 - \frac{p \times n}{M}\right)^r$

If periodic count frequency is $\frac{1}{R}$ (i.e. every R th day). Then average IA$= \frac{\sum_{i=1}^{R}\left(1 - \frac{p \times n}{M}\right)^i}{R}$

From the above derivation we get that the smaller will be "p" i.e. probability of error per transaction, higher will be IA.

Similarly higher will be ratio of requisition in a day "n" and total items in store "M", smaller will be IA. Also smaller will be the period after which periodic count will be carried out higher will be IA because $\left(1 - \frac{p \times n}{M}\right) < 1$.

As "p" depends more or less on system properties like access to store, product structure, level of standardisation, storage system, quality policy system of issue, coding system etc., it can not be controlled very easily. So for increasing IA one effective measure will be to increase the physical verification per transaction.

In deriving the above result some important assumptions were made as below:

I. There is no error just after doing periodic count i.e. people doing physical verification makes no error and physical verification is done for all the items of the store.
II. The error due to transaction is randomly distributed in items
III. The probability of error per transaction is static and not dynamic.
IV. There is no other way to correct mismatches except by people doing periodic count.

4.3.5 Effect Of Physical Verification On The Level Of Mismatch:

On the basis of above results we will find the effectiveness of level of physical verification on the overall level of mismatch in a warehouse. For this we will calculate number of items physically verified and the number of issues in a year for each of the companies we

studied. Then we will calculate the ratio of number of items physically verified and number of issues in a year for each of the organisations of our study. We will refer it as physical verification ratio(PVR). This will give us an idea of level of physical verification. We will compare this level of physical verification with overall level of error in each of the organisation to see the effectiveness of level of physical verification .

4.3.5.1 Analysis For Level Of Physical Verification In Organisations Under Study:

In this section we will calculate ratio of number of items physically verified and number of issues in a year. This ratio will give us a basis for across the organisations comparison of the physical verification level.

4.3.5.1.1 TELCO:

In TELCO physical verification of items in store is done annually. As there are total of around 3000 items in the store, in a year 3000 items are physically verified per year. Per day physical and computer stocks of approximately 10 items under shortage are adjusted. They are working 6 days a week. So per year around 3000 items are adjusted in this way. So in a year stock verification for total 6000 items is done.

Around 500 issues are made in this organisation per day. So total issues in a year are approximately 500×300=150000

$$\text{PVR}=\frac{\text{Items physically verified in a year}}{\text{Transactions in a year}}=\frac{6000}{150000}=0.04.$$

4.3.5.1.2 DUNCAN:

Per year they are doing physical verification of approximately 33000 items by cycle counting method.

Around 200 issues are made in this organisation per day. There are 5 working days per week in this organisation. So total issues in a year are approximately 200×250=50000.

$$\text{PVR}=\frac{\text{Items physically verified in a year}}{\text{Transactions in a year}}=\frac{33000}{50000}\approx 0.66.$$

4.3.5.1.3 GEC:

Six monthly physical verification is carried out in this organisation. As number of items in this store are approximately 3000. So in a year approximately 6000 items are physically

verified. Per day approximately 80 items are issued and there are six working days per week in this organisation. So total issues in a year are approximately 300×80=24000.

$$PVR = \frac{\text{Items physically verified in a year}}{\text{Transactions in a year}} = \frac{6000}{24000} = 0.25.$$

4.3.5.1.4 LML:

Six monthly physical verification is carried out in this organisation. Number of items in this store are approximately 3000. So in a year approximately 6000 items are physically verified in this way. Per day each material handler of store has to carry out physical verification of approximately 4 items out of items assigned to him. There are 6 working days per week in this organisation. So each material handler does physical verification of approximately 300 × 4=1200 items in a year The number of items assigned to each material handler are approximately 350. Total items in store are approximately 3000. So total items physically verified by all material handlers in a year = $1200\times\frac{3000}{3500} \approx 10300$.

So total number of items physically verified every year are approximately =10300+6000=16300.

Every day around 500 items are issued and there are six working days per week in this organisation. So total number of issues in a year are approximately 500×300=150000.

$$PVR = \frac{\text{Items physically verified in a year}}{\text{Transactions in a year}} = \frac{16300}{150000} \approx 0.11$$

4.3.5.2 Comparison Of Level Of Physical Verification And Overall Level Of Mismatch:

We have calculated the ratio of number of items physically verified and number of transactions in a year(PVR), for each of the organisations of our study in section 4.3.5.1. This ratio will give us an idea about level of physical verification in each organisation. We will compare this ratio with overall level of mismatch in each organisation to get the idea of effect of level of physical verification on level of mismatch in a warehouse. The basis of this comparison is that physical verification reduces the overall level of mismatches in a store and hence this comparison will give us an idea of effectiveness of physical verification on level of mismatches. We summarise the results of our computations in the table 4.7.

Table 4.7 Comparison of Physical Verification and Level of Mismatch

Company	Level of Physical Verification(PVR)[1]	Perc. Level of Mismatch[2]
TELCO	0.04	88%
DUNCAN	0.66	10%
GEC	0.25	30%
LML	0.11	9%

(Notes: [1] Level of physical verification(PVR) = $\frac{\text{Items physically verified in a year}}{\text{Transactions in a year}}$

[2] For "Percentage Level of Mismatch" refer to 3.2.1, 3.1.1.1, 3.3.1.2 and 3.4.1.2 respectively)

From the table 4.7, we observe that there is a general trend that as the level of physical verification is increasing the level of mismatch is decreasing.

The lower level of mismatch is being observed in the case of LML as compare to DUNCAN and GEC although the level of physical verification in LML is lower than these two companies. This can be due to the reason that LML has a higher level of computerisation. This is evident from table 4.7(a), which shows the impact of both the factors together.

Table 4.7(a) Combined impact of Computerisation & Physical Verification

Company	Level of Physical Verification(PVR)	Level of computerisation	Perc. Level of Mismatch
TELCO	0.04	Low	88%
DUNCAN	0 66	Medium	10%
GEC	0.25	Medium	30%
LML	0.11	High	9%

In summary we conclude on the basis of above analysis that higher will be the level of physical verification, lower will be the deviation between physical and computer stocks.

4.4. SYSTEM OF STORAGE OF ITEMS:

After the receiving and quality testing item is kept in store from where it is issued to production, when the need arises for the item So the basic requirement for a good storage system is that it should be capable of locating the item in store as soon as item is required. If location of storage of an item physically present in store is not known then it is as good as being lost because in a big warehouse time for searching a lost item may be enormous. For the storage of items we can use following systems.[Tompkins(1988)]

I. Informal system

II. Random location system

III. Fixed location system

We reproduce brief outline of these three systems from Tompkins(1988).

4.4.1 Informal system:

This system basically works on following two assumptions:

a) Inventory will be stored wherever there seems to be space, and

b) The ability of those in the warehouse to remember where they stored the items.

An informal system implies that no records are kept which only works (although seldom well) when everything about the environment in which it is operating is small:

a) A relatively small number of different SKUs, and

b) A relatively small number of different storage locations.

This is imposed by simple human limitations and the inability to remember too many facts. A further restriction on such systems is that the number of persons required to store and retrieve stock must by necessity,be low More than one person can work in the same storage area so long as they communicate well and the means for doing so are in place. Of course that is an ideal view of reality. One quickly learns that as soon as someone is charged with retrieving an item that someone else has stored, the information system shows signs of deterioration. Therefore the practical reality of an informal system pretty much dictate that only one person work as a stock handler in a given storage area.

In certain ways, an informal system may be seen to operate as a random location system, where material can be stored anywhere where there is a room. The truth of the matter is, so long as the smallness criterion is met, the stock handler should be capable of

remembering where like items are stored and will use this knowledge to store additional items so long as there is a space. Short of space the stock handler is likely going to add the new stock to an available stock location closed to the first one, and so on. While there maybe some rhyme and reason to a stock handler's action, it is all quite informal, and little or no documentation exits to help others locate items in the warehouse.

4.4.2 Random Location Systems:

In this system formal record of each location is kept either manually on paper or in computer. When any new item has to be stored it is given some suitable location out of available free locations keeping constraints like size, weight of the item, fork lift capacity etc. in mind. If locations are assigned with the help of computer then additional decision rules can be employed to facilitate meeting multiple objectives, such as minimised travel time. The record of item at this location is kept

At the time of retrieval stock location record for the item is pulled (again either manually or via computer) for the purpose of finding storage locations. From the locations we select locations and the quantity to be withdrawn to supply item in required quantity. While selecting locations of withdrawn considerations like FIFO or nearest location from dock etc. can be taken. Again with the use of computers we can select locations for the withdrawal of multiple items at a time so that travel time is minimum

If properly designed (with simple easy to read records)and properly maintained (in a timely and accurate fashion) a random storage location system can generally result in a very high utilisation of space. It is particularly well suited to computer based implementations.

4.4.3 Fixed Location System:

In such system, the location of every item is always known. this is brought about by requiring that every stock item is assigned a specific and unique location in the warehouse. In theory no other item may be stored in a location assigned to another item, even if the location is currently empty.

The choice of specific location assignment can make a definite difference in warehouse efficiency, as measured by the time it takes to store and retrieve items. Ideally high volume items for which there is a relatively large number of transactions in a given period of time, should be located close to the point of usage. Low volume, low throughput items can be

assigned storage locations that are further from the point of use. In a distribution warehouse, the point of use is defined as the receiving and shipping areas.

The primary disadvantage of the fixed location system as compared to the random system is that it makes poor use of space, since each location has to be designed to accommodate maximum number of items to be stored at a time. In practice, when insufficient space is available, stock handlers often begin to make decision on the floor, and they start storing overflow items in locations previously assigned to other items.

4.4.4 Storage Systems For Organisations Under Study:

The storage system of stores of organisations included in this study were as below:

4.4.4.1 TELCO:

Locations for each item has been pre-arranged Organisation is following fixed location system without giving any consideration to turnover of items in location assignment. Items of same type are stored together. (refer to 3.2.2.2.1.1)

4.4.4.2 DUNCAN:

Organisation is using random location system. For the purpose of keeping storage location record organisation is using manual system. At a location generally more than one items are stored.(refer to 3.1.2.2)

4.4.4.3 GEC:

System of storage is informal system in this organisation. (refer to 3.3.2.2.1.1)

4.4.4.4 LML:

In one section of store the system of storage is computer based random location system. FIFO policy is under practice in this section. (refer to 3.4.2.2.2.2.1)

For rest of the items informal system of storage is under practice in this organisation. But the responsibility for a part has been permanently assigned to one and only one stock handler of store. He is responsible for storing and issuing of the items assigned to him. The number of items under each material handler are around 350.(refer to 3.4.2.2.2.2.2)

4.4.5 Effect Of Storage System On The Mismatch:

In the subsequent section we will analyse the problem of mismatch created due to system of storage with respect to each of the organisations studied. We will study the impact on mismatch due to following aspects of storage system:

I. Location Policy.

II. Multi-item storage at a single location.

4.4.5.1 Location Policy:

We will consider the impact of location policy on mismatch by two indicators:

a) False stockouts.

b) Mismatch of locations.

4.4.5.1.1 Observation For False Stockouts In Different Organisations Of Our Study:

"False Stockouts" are defined as the cases where computer is showing stock for an item and the item is physically present in store, but it could not be issued against a requisition because issuing persons are not able to locate it.

In the subsequent sections we will discuss the problem of "False stockouts" with respect to location policy in different organisations of our study.

4.4.5.1.1.1 TELCO:

This organisation has fixed location system. Responsibility for the storage of each item has been permanently assigned to one and only one stock handler of store. It is his responsibility to bring item from receiving area after quality inspection and keep it at its specified location. The line feeders reported, that there is no problem of false stockouts. This may be due to the reason that even if person responsible for storing an item has kept that item at other than the specified location, in case of need he is able to inform the line feeders the location of storage of that item.

4.4.5.1.1.2 DUNCAN :

DUNCAN uses random location system. Location of storage of every item is recorded on paper.

To get the level of "False stockouts". we studied the reasons of stockout from available documents. In 1st six months of financial year of 1996-97 total issue were 20641 while total requisitions which could not be served were 1001 which is around 4.8%. We collected a random sample of 42 such requisitions which could not be served from the report of refusals. In this sample 22 requisitions were such that item had been ordered but the item had not been supplied by supplier while 19 requisitions were such that item had been indented by store but order had not been placed by supply department. In one case the item had been out of stock due to nil quantity of its physical stock. So we infer on the basis of above sample that there is no problem of "False stockouts", i.e. item is lying physically in store but it couldn't be issued.

4.4.5.1.1.3 GEC :

Informal system of storage is existing in this organisation. there are around 3000 items in store. Any person of store can store and issue any item So both the conditions responsible for showing signs of deterioration as discussed in section 4 4.1 (Informal System) are present here. As per the information received from the main issue store in charge, every day there is atleast one case of False stockout.

4.4.5.1.1.4 LML :

In the FIFO section computer based random location system is under use.

In the section where FIFO is not implemented informal system of storage is practised But in this organisation the responsibility for every item has been assigned to one stock handler of store. After inspection by quality every stock handler of store will store items assigned to him in his area. At the time of issue only he is authorised to take bin out from storage area and issue the required quantity from the bin. So in every area only one person is doing job of storing and issuing. The number of items under the responsibility of each person are 350. This is much less than the case of GEC where the number of items were 3000 and no responsibility was fixed on any one for any item for storing and issuing.

The Store manager informed us that there is no problem of false stockouts in FIFO as well as in non FIFO section. During our study also we observed no case of false stockout.

On the basis of above analysis we find that the problem of "False stockouts" is in informal system when the a number of items are high and many people are storing and issuing in the same area (refer to 4.4.5.1.1.3). There is no problem of "False stockouts" in random location system and fixed location systems of storage

We also observed that time for locating an item in GEC is much higher (as high as 30 minutes) compared to other organisations where it is less than 5 minutes. This can be assigned due to informal system of storage without any specific responsibility for the item to a person.

In summary we conclude that there will be problem of False stockouts, i.e. computer is showing stock of item present in store and it is physically present in the store but it could not be issued against a requisition, for informal system of storage when number of items are high and many people are storing and issuing in the same area.

4.4.5.1.2 Mismatch Of Locations:

To get an idea of impact of location policy on mismatch we will analyse the problem of mismatch of location for the random location system of storage.

Mismatch of location is defined as the case when item is present in store at a location other than as per the location details maintained either on computer or on paper.

4.4.5.1.2.1 Basis:

In random location system, locations are not fixed. So at the time of storage, if item is not kept at a location given by computer for this item or location recorded in location card then when this item will be needed it will not be at its location given by record. In such cases, when item is required, it has to be searched in the whole store, which is very time consuming. In most of the cases it may be as good as being lost.

Following are the observations about level of mismatch of locations in two organisations under this study, where random location system of storage is used, i.e. LML FIFO section and DUNCAN.

4.4.5.1.2.2 LML FIFO section:

Out of three racks in store in which system of storage is random location system, we selected two racks at random and comparison between item stored at each location as per computer record and actual item stored at that location were made. The result of study for mismatch of location in these two racks are given in table 4 8.

Table 4.8 Mismatch of locations for FIFO section of LML

Rack No.	Mismatch in locations*	Total locations
10^{th}	8	231
11^{th}	8	231

(Note * refer to 3 4.2.1)

Mismatch in location in table 4 8 is number of items kept at wrong location

So percentage of bins placed at wrong location $= \frac{8}{231} \times 100 \approx 3.5\%$.

So we estimate that there is a mismatch of location in around 3.5% cases in this section.

4.4.5.1.2.2 DUNCAN :

For the purpose of our study we selected a section in this store where items are kept in cardboard boxes because item code as well as location of storage as per record is written on these boxes. Error was observed in 28 locations out of 1800 locations studied.

So error due to mismatch of locations $= \frac{28}{1800} \times 100 \approx 1.5\%$.

It may be noted that section, which we studied was such that at each location only 16 card board boxes could be accommodated, and each box contained only one item. It is likely that at other locations where space constraint is not there mismatch will be higher

The person responsible for reconciliation after physical verification informed us that 15-20% of the total items in which error is reported, are due to the mismatch of location

As total discrepancies are estimated in around 10% of the items (refer the section 3.1.1.1), so we estimate that mismatches due to placing item at wrong location is in around 1.5% to 2.0% of the total items.

In summary we conclude that in random location system there is problem of mismatch of location i.e. keeping item at location other than given by record.

4.4.5.2 Multi-item location:

Multi-item location is defined as system of storage in which more than one item is stored at a location This problem was observed only in DUNCAN as in other organisations there was no multi-item location system for storage Below we will observe the effect of keeping more than one items at a location

4.4.5.2.1 Basis:

When more than one item is stored at the same location and issuing person is unaware of the part, then he may issue wrong item from same location. But as requisition was given for other item located at the same location, it will become more than computer stock and physical stock of the item actually issued will become less than the computer stock because no reduction has taken place in computer stock of this item. The problem is similar as due to non-standardisation in the components, where similar items are issued in place of requisitioned item.

4.4.5.2 2 Observations:

To find the effect of system of multi-item location we observed the following:

I. Study in requisition book of maintenance to get an idea of percentage wrong issues from same location out of total issues.

II. Estimation based on information provided by person responsible for reconciliation to get estimate of percentage items of store under error due wrong issue from same location.

4.4.5.2 2 1 Wrong issues as a percentage of total issue:

To get the idea of mismatch due to keeping more than one item at a location and as a result wrong issues as a percentage of total issues, we studied one requisition book of production. Our basis of finding error due to issue of item other than the requisitioned item from same location was that if from store some wrong item has been issued, then the maintenance is likely to request the original item in the same quantity again, because they have not got the item of their requirement from previous requisition slip.

We considered cases only those cases, in which quantity requested was less than 10, because for some hardware items with large lot size, the requisition can be made more than once. Further these items are generally stored in single item location.

Out of 100 requisitions in a serial taken in a requisition book we observed, there were 8 cases when same item code was requested for issue in the same date in the same quantity.

On the basis of above sample we estimate that about 8% of total items issued are wrong due to multi-item location On the other hand the maintenance estimated the error due to this reason to be in about 20% of total issues

4.4.5.2.2.2 Percentage of total items of store under error due to multi-item location:

The person doing reconciliation after physical verification informed us that generally 10 - 15% of total discrepancies are due to issue of other item from same location. He informed us that the error due to this reason are assumed, when there is excess in one item and shortage in other item of same location in near about same quantity. As the deviation is in around 10% of the items (refer to 3.1.1.1), so we estimate that there is deviation due to keeping more than one item at a location in around 1-1.5% of total items present in store.

In summary we conclude that multi-item location system of storage creates the problem of mismatch, due to wrong issue of the items.

4.5 QUALITY INSPECTION POLICY:

Quality can be defined as fitness for the use. It must be made sure that the item used is fit for use. For making sure that item conforms to various specifications, required testing on a sample drawn from received lot are carried out. Testing may be either destructive or non-destructive as per requirements. Destructive testing may be needed for testing strength, composition, structure etc. While non-destructive testing may be needed for dimensional testing, electrical properties etc. The latest concept for quality assurance puts less emphasis on testing to decide whether product is OK or not. It is giving more stress on process improvement so that the items coming out are quality products and hence there is no need for carrying out test inspections when item is received in the store.

4.5.1 Quality Testing Required In Different Organisations:

Quality policies in regard to incoming material inspection for different organisations are discussed briefly as below:

4.5.1.1 TELCO:

For every lot received destructive as well as non destructive testing are carried out. Destructive testing are done for metallurgical inspections while non destructive testing is carried out for dimensional inspection.

4.5.1.2 LML

Quality policy for this organisation is same as in the case of TELCO.

4.5.1.3 GEC:

Generally for every lot received non destructive testing is carried out to test the electrical properties.

4.5.1.4 DUNCAN:

In this organisation most of the items received are standard products of suppliers. So generally no inspection is carried out for the items received.

We will analyse the effect of different quality policies in regard to incoming material inspection on the problem of mismatch in the following sub-sections

4.5.2 Basis:

If destructive testing is carried out, then item is consumed by quality. But generally at the time of taking sample for destructive testing, it is not shown issued to quality. Hence due to item being consumed in destructive testing by quality, without being properly recorded in computer record, a stock mismatch will get created between physical stock and computer stock, which will be equal to sample size for destructive testing. It is true that it will create very small deviation, but the error will get accumulated in future after a number of lots are received and will result into sizeable deviation between physical and computer stocks

As the number of items taken for destructive testing from a lot are very few (generally one or two), it is likely that store may not take proper care to show it as consumed by quality.

Samples are also taken for non destructive testing. After doing the testing these samples should be returned back to the lot from where it was taken. If the samples taken for non destructive testing are not returned back then a deviation will get created between physical and computer stocks If location of the lot from which sample was taken in receiving area is not specified then it will be difficult for quality person to return item back to original lot, creating discrepancies

4.5.3 Observations For Mismatch Due To Quality Inspection Policy:

As described in section 4.5.2, mismatches can get generated due to test inspection of incoming material. We shall analyse the problem of mismatch with respect to following three policies for quality test inspection:

I. Impact of destructive testing.

II. Impact of non destructive testing.

III. When no sample is drawn for test inspection.

4.5.3.1 TELCO:

For getting the idea of impact of quality test inspection, we selected a sample of 8 items.

The sample was selected out of items in the receiving area, for which quality testing had been carried out. While taking the sample to study the impact of quality test inspection on mismatch, we selected items of weight more than around 0.5 kg, because for small parts there may be deviation at the time of receiving itself. "Quantity Reported" was taken as the quantity written on paper attached with the lot. We verified ourselves the actual quantity present and recorded it as "Actual Quantity". The result of sampling are given in table 4.9.

Table 4.9 Sampling For Mismatch Due to Quality Test Inspection

Sl. No.	Part Number	Quantity Reported	Actual Quantity	Notes
1.	2574 4270 0138	53	53	Wt. around 3 Kg Can be counted easily
2.	2573 4270 0156	60	58	Wt. around 0.5 Kg. Comes in a packing of 10 in a bundle. So can be counted very easily
3.	2573 2900 148	100	99	Wt. around 400 gm. Can be stocked with a little difficulty
4. 5. 6.	2060 3510 4207	28,24,24	27,23,23	Three packets were showing quantities 28, 24 and 24 respectively Wt. around 500 gm.
7.	3505 8306 7703	125	121	

Quality informed us that for the items listed in table 4.9 quality testing required is as below:

a) For item at Sl no. 1, there is only visual inspection required and no sample is taken either for destructive testing or non destructive testing. When it is received, quality inspector inspects some major dimensions in the receiving area itself.

b) For items at Sl. no. 2, 3, 4, 5, 6 and 7, one item is taken for destructive testing from each lot. There is no system to adjust deviation due to items consumed in destructive testing in this organisation. So there is discrepancy of one item for all the six items listed above, for which the destructive testing is carried out.

c) The persons from quality, who had drawn samples for dimensional testing informed us that for items at Sl. No. 2 and 7; 1 and 2 items were taken for dimensional testing respectively,

but the samples were not returned to original lots. Dimensional testing was carried out for items at Sl. nos. 2, 3, 4, 5, 6 and 7. So out of six items for which sample was taken for dimensional testing, in two items i.e. in 33% cases, a deviation was created.

So for TELCO we estimate that:

a) There is always an error due to sample drawn for destructive testing.
b) The error due to non destructive testing is estimated to be in around 33% lots in which sample for this purpose was drawn.
c) There is no error in items for which sample is not taken neither for destructive testing nor for non destructive testing.

4.5.3.2 LML:

In this company sample to quality is given by only one person from the store and he himself takes back the samples after testing. He informed us that samples drawn for non destructive testing is always kept back to original lot. As locations in receiving area are numbered, and the location of lot is written on GRN. items are put back to original lot after testing. However one or two items taken for destructive testing are not returned back to original lot.

For getting the idea of mismatch created due to destructive testing we took a random sample of one item. This item was going to be stored in the FIFO section after quality inspection when we took sample We took quantity written on paper for this item as "Quantity Reported". We ourselves verified the actual quantity present in this lot and recorded it as "Actual Quantity" The observation for this sample are given in table 4.10

Table 4.10 Sample for Mismatch Due to Destructive Testing in LML

Part No.	Quantity Reported	Actual Quantity	Deviation
C-270984	90	89	1

It was further informed that store will get requisition for item used in destructive testing latter from quality and then item issued will be shown as "Quality consumed". But we observed that in existing list of stock of items the stocks are in round figures like 100, 150,

200 etc. and entries like 99,148,198 etc. could not be observed. Which shows that although there is a system of "Quality Consumed" but in practice it is not followed otherwise there must have been entries like 99, 148, 198 also, showing one or two items issued as quality consumed for destructive testing.

In summary we conclude that there is always deviation due to sample drawn for destructive testing by quality. Sometimes mismatches will be there due to not returning the sample drawn for non destructive testing. There is no error due to quality test inspection for items in which no sample is drawn either for destructive testing or non destructive testing. However the size of such error is small.

4.6 ACCESS TO STORE:

Inventory managers are judged on the basis of efficiency with which they handle inventory and the shortages that occurred. The efficiency of inventory manager can be measured in terms of actual versus budgeted inventory, slow moving and non moving items etc On the other hand performance of production people are measured on the basis of production efficiency and degree to which production plans were met. It is therefore of little interest to production whether or not inventory records were correctly kept. Their only concern is about material required for production so that there is no loss of production. So the common feeling among the store managers is that there should be no access to production people inside the store . The top management can also not held store responsible for inaccurate inventory unless access to store is controlled. Thus the access to store is an important consideration in controlling mismatches.[Young(1991)]

4.6.1 Observations For Access In Different Stores:

Following are the observations regarding access to store for organisations which we studied:

4.6.1.1 TELCO:

The line feeders have responsibility of withdrawing bins from storage locations and supplying to production line before the inventory on production line reaches to zero level.. The line feeders are under store management, but their basic responsibility is to supply items on production line so that production is not stopped. They don't have any responsibility towards keeping the proper record of inventory. So the sole criteria for measuring the efficiency of line feeders is to supply items from store to production at right time and they are not held accountable for proper record keeping of the item being issued. Hence although line feeders are in store under organisational chart but due to the nature of their responsibility they are primarily working for production.

From the rejection and scrap area stores, line feeders can not take any item without getting prior permission from quality. But as these stores are not locked so as and when some item is under shortage and it is not available either in central material store or in receiving store, line feeders try to pick it from rejection area store, most of the time without giving proper requisition.

In summary the store is accessible to line feeders, who although are under control of store but primarily are interested i moving the material without paying due attention to record keeping.

4.6.1.2 DUNCAN:

Generally the production is not given access to the stores. Store people take the requisition slip from production and find location of part from location record, and issue it to production. However limited access is available to production, especially when store persons are not able to identify the part and during the night.

Preferable items like cells, hacksaw blades and other items of daily use are kept in locked area.

4.6.1.3 GEC:

Production persons enter many time inside the store to pick item that can serve their purpose. During night although one person of store is present, generally persons of production enter inside the store and draw the required item without giving proper requisition slip.

Stores other than common consumable items store are locked and only store staff can enter there.

The receiving store is locked and only receiving store staff can go there.

The rejection and scrap store is also locked and only people of quality department can go there.

4.6.1.4 LML:

Production department sends the requirement for next day, on the basis of which store keeps the required quantity of items in bins for line feeding. The production department persons can not draw items directly from its location of storage in store, and they can pick only their bin for line feeding.

Although receiving area is unlocked but the production people can draw item from this area only against requisition store slip. During night there is one person of store to issue the items.

In summary access to the store is limited to store persons only.

4.6.2 Basis:

We shall examine the impact of access to store of production on mismatch in the following two ways:

I. Within the same organisation comparison of the overall levels of mismatch for sections of store with different levels of access.
II. Comparison of the mismatches due to unauthorised removal among stores of different organisations, with respect to the levels of access to the store.

For making comparison within the organisation, we shall examine the overall levels of mismatch in different sections of store with different levels of access. As the nature of responsibilities of production and store persons are different, production persons while issuing item themselves are more likely to make errors like taking quantity more than written on requisition slip, not keeping the box back at its location after withdrawing required number of items from the box, taking item of near about same size of item given in requisition which will serve their purpose etc. These errors will get reflected in overall levels of error of that section of store.

For across the organisation comparison , we will classify the access to store in 4 different levels i.e. "Full", "Medium", "Low" and "No Access". Then we will classify the various sections of the stores of the different organisations under our study at one of the above four levels and find the mismatches due to unauthorised removal for each of the sections. We will then use this estimate to relate access to the store with level of mismatch. In this study we are assuming that unauthorised removal is mainly due to withdrawal of item without proper requisition being given.

4.6.2.1 Classification Of The Stores With Respect To Level Of Access:

We have classified the sections of stores of organisation under our study on the basis of level of access as below:

4.6.2.1.1 Full Access:

Stores in which production persons are permitted to pick item from inside of the store are labelled as "full access" store.

I.TELCO receipt section and

II.TELCO central material store.

4.6.2.1.2 Medium Access:

In this store, production persons are not authorised to draw item from inside the store, but as the store is not locked, production persons sometimes go inside the store to withdraw the desired item. Examples are

I.DUNCAN unlocked area

II.GEC main issue store.

4.6.2.1.3 Low Access:

In this store, production persons are not authorised to draw item from inside the store. They also generally don't go inside the store to draw items themselves. But the store being unlocked, in case of emergency they go inside the store and withdraw the item. Examples are

I.TELCO rejection and scrap area store

II.LML stores.

4.6.2.1.4 No Access:

This store will be locked and no person other than store persons can go in this store. Examples are:

I. DUNCAN locked area

II. GEC locked stores for job specific items

III. GEC receiving area

IV. GEC rejection and scrap area.

4.6.2.2 Impact Of Access On Mismatch - Within Organisation Comparison:

In this section we will compare the overall level of mismatch of different sections of store of same organisation with different levels of access:

4.6.2.2.1 DUNCAN:

In this company there are two different sections in issue store. One is unlocked and second is locked area. Production persons come sometime during day in unlocked area and during night they themselves draw the item from this section. But in locked area only store people are permitted to go. Table 4.11 shows the level of mismatch for these two stores.

Table 4.11 Impact of access level on mismatch within DUNCAN

Section	Level of Access	Level of mismatch
Unlocked area	Medium Access	10%.[1]
Locked area	No Access	2%.[2]

(Notes [1] and [2] : refer to section 3.1.1.1 and 3.1.1.2 respectively)

4.6.2.2.2 GEC:

In this company the issue store for general items is unlocked. Production people come sometimes inside this store. But all the different job specific items are kept under locked area(refer to section 2.3.2.2.1). Table 4.12 shows the level of mismatch for these two levels of access.

Table 4.12 Impact of access level on mismatch within GEC

Section	Level of Access	Level of mismatch
Unlocked area	Medium Access	34.38%[1]
Locked area	No Access	nil[2]

(Notes [1] and [2] : refer to sections 3.3.1.2 and 3.3.1.1 respectively)

On the basis of above two samples we find that overall level of error is much lower in area in which access is limited compare to those areas where access is relatively free.

4.6.2.3Impact of Level of Access on Mismatch : Comparison among Organisations:

In this section we will discuss the impact of access level to the store on mismatch due to unauthorised removals in stores of different organisations with different levels of access. For each level of access we will make comparisons among the stores of different organisations having same access level.

4.6.2.3.1 Full Access:

4.6.2.3.1.1 TELCO:

In both the central material store and receiving area, the level of access is same. In the receiving area there were cases of unauthorised removal of items which were primary reject. When the people of quality searched for these items in rejection area for purpose of storage, then they could not find it. These items were also not entered in "diary issue", as emergency issue with the consent of quality. The quality raised "Material Not Found" note for such discrepancies in primary rejected item. There were approximately 100 such "Material Not Found" notes raised in first seven months of financial year of our study. In a year there are around 5000 primary rejected lots. Hence we can estimate that till physical verification at the end of financial year error will be in $100\times(12/7) \approx 171$ lots of different items.

Estimated percentage of primary rejected lots, in which error will be due to unauthorised removal = $(171/5000) \times 100 = 3.42\%$.

Line feeders are withdrawing any item from receiving store required on line. So the probability of unauthorised removal of primary rejected item and those which are not primary rejected will be same. Hence we estimate that error due to unauthorised removal in receiving store is in 3.42% lots out of total lots received.

Per day around 100 lots are received . So in a year of 300 working days, total lots received will be about 30000. As the total items in store are around 3000. Assuming that on average same number of lots are received for each item in a year, the average number of lots received for each item ≈ 10.

If "p" is the probability of unauthorised removal in a lot received, from receiving store. Then the probability that there is no error in an item after receiving "n" lots, due to unauthorised removal from receiving store, will be $(1-p)^n$.

For this organisation "p" = 0.0342 and

"n"= 10.

So probability of no error due to unauthorised removal from receipt store, in an item at the end of financial year = $(1-0.0342)^{10} = 0.706$.

So the probability that, there will be error in an item due to unauthorised removal from receipt store at the end of year = 1-0.706=0.294

On the basis of above analysis we estimate that the error due to unauthorised removal is in approximately 30% of items in store with full access.

4.6.2.3.2 Medium Access:

4.6.2.3.2.1 Main issue store of GEC:

. To get an idea of error due to unauthorised removal 4 samples of 48 items each were studied and number of items under excess or shortage in a sample were recorded. The results of sampling were given in table 3.14. Now we will assess the error due to unauthorised removal from observations of this sample. The error due to unauthorised removal is calculated after taking into consideration the error introduced due to items of near about same size being withdrawn. So the minimum error due to taking item without giving any requisition i.e. unauthorised removal will be obtained by reducing excess from shortage. This error is denoted by (x) in column 4 of table 4.13.

Table 4.13 Mismatch due to unauthorised removal in main issue store of GEC

Sample No. (1)	Excess (2)	Shortage (3)	Minimum Error (x) (4)=(3)-(2)
1.	2	12	10
2.	16	18	2
3.	12	19	7
4.	15	19	4

Average number of items having error due to unauthorised removal $(\bar{x}) = 5.75$

So percentage error due to unauthorised removal is in $\frac{5.75}{48} \times 100 = 11.98\%$ items.

This data is for mismatch at the time of six monthly physical verification . Just after the physical verification the level of mismatch will become zero . So we can say that on average there will be error in $\frac{(0+11.98)}{2} = 5.99\%$ items throughout the year .

Thus we estimate that mismatches in about 6% of the items are due to unauthorised removal .

This is a lower estimate of the error, as the error due to removal of similar items is overstated.

4.6.2.3.2.2 DUNCAN:

From the information provided by person responsible for reconciliation of the discrepancies, reported after physical verification, it appears that there are 25-30% items for which no specific reason for mismatch could be assigned. We assumed that this is primarily due to item being taken without proper requisition. This error can be attributed to access level to the store. As there is total deviation in around 10% of the items (refer to section 3.1.1.1). So we estimate that mismatches in around 2.5% to 3.0% items can be attributed to the access to store.

From the above two samples we estimate error due to access to store is in around 2.5% to 4.5% for the access level "medium".

4.6.2.3.3 Low Access:

4.6.2.3.3.1 Rejection and scrap area of TELCO :

In the primary rejection store there is unauthorised removal of about 25 items in a year. In scrap area store there is unauthorised removal of 5 items in a year(refer to 3.2.2.4.b). So the error in total items of the store due to unauthorised removal is $= \frac{(25+5)}{3000} \times 100$ =1% items.

So we estimate that error due to unauthorised removal from rejection and scrap area stores is in around 1% of total items in this organisation.

4.6.2.3.3.2 LML:

During one week in which observations were taken, there was only one case of unauthorised removal by production from receiving store in night due to emergency requirement (refer to 3.4.2.4). Thus the error in total items of the store due to unauthorised removal in one year is $= \frac{52}{3000} \times 100 \approx 1.7\%$ items.

Our estimate of the error due to unauthorised removal are 1.7% items for this organisation.

So from the above two samples we estimate that error due to access to store is around 1% to 1.7% items for store of "low" access.

4.6.2.3.4 No Access:

4.6.2.3.4.1 Locked area of DUNCAN :

The error in this section is in around 2% items (refer to section 3.1.1.2). However this overall error may be due to reasons like difference in unit codes of issue and purchase, issue of items of near about same characteristics (e.g. leak proof and non-leak proof cells), placed at

nearby area during issue, in addition to unauthorised removal. The chances of unauthorised removal are less in this section than unlocked area. No direct evidence to estimate this error was available. If we consider the observation that in general area (Medium Access) the error due to unauthorised removal is in 25%-30% of the total mismatches reported after physical verification, then after taking the same proportion of error due to unauthorised removal in total mismatches for this lockup section also, mismatch due to unauthorised removal is estimated to be around 0.5%-0.6% of total items present in lockup area.

4.6.2.3.4.2 Rejection store of GEC :

This store is locked. It was confirmed both by manager quality control and person incharge of rejection store that there is no case of unauthorised removal from this area in a year. So, we estimate the error due to unauthorised removal in this area is nil.

4.6.2.3.4.3 Locked stores of GEC :

All job specific items and kept in locked area. The error in this area is nil (refer to section 3.3.1.1).

So on the basis of above three samples we estimate that the error due to access to store is in around 0% to 0.6% items for the store of "No Access".

4.6.2.4 Comparison of different levels of access and mismatch:

We summarise the outcome of analysis carried out in section 4.6.2.3, in table 4.14.

Table 4.14 Summary of mismatches related with level of access

Sl. No.	Level of access	Error
1.	Full Access	30%
2.	Medium Access	2.5%-4.5%
3.	Low Access	1%-1.7%
4.	No Access	0%-0.6%

It can be observed from table 4.14 that lower is the access into store, lower is the level of mismatch between physical and computer stocks.

In summary we conclude that level of access to stores has considerable impact on mismatch. The level of mismatch is increasing as the access to store is increasing.

4.7 ISSUE SYSTEM:

For the purpose of production material has to be moved from store to manufacturing area. This movement can be either under "Pull" or "Push" system.[Young(1991)].

I. Pull system:

In this system, material is moved to the shop when production requests it. Production, in other words, calls on the inventory system for delivery of material as necessary. The inventory system has no prior knowledge of what will be required and when.

The pull system is appropriate under certain circumstances such as when delivery to production must be made quickly, multiple deliveries will be required for the completion of a work order and precise co-ordination of deliveries with usage will be important On the other hand, the need for storage space in production will be limited and material in the shop will turn over quickly.

II. Push system:

In this material is moved to production in response to a prearranged plan such as a production schedule or a work order Push system is appropriate when delivery times are long and where all the material required for a work order can be delivered at once. Temporary storage must be provided in production for material that has been delivered but has yet not been processed.

4.7.1 Issue Systems In Organisations Under Study:

Brief description of the issue system of different organisations under this study is given below:

1. TELCO:

When the line feeders estimate that some item is going to be finished on production line then they come to store and draw the bin of that item. Earlier the issue entry was done manually in a register, in which part number and quantity issued was entered by line feeders. However currently, there is one bar coded slip inside each bin, specifying the part code and quantity. These slips are handed over to the issue section at the time of issue.

If the item is not in store, then receiving area is checked. If item is lying there then with the permission of quality, it is picked up from there and written in diary issue

The system is similar to pull system without written requisitions.

2. DUNCAN:

Maintenance sends requisition slip to the store. Store finds location of item written in requisition slip. From that location item will be issued. This slip will be kept by store for future record and entry of issue will be made into computer. In this company system of issue is Pull system.

3. GEC:

Requisition is raised by the production on computer. Store issues the item on the basis of this requisition. Issue is recorded in computer and paper slip of requisition is kept for future record. In this company system of issue is Pull system.

4. LML:

On the basis of production plan the production sends the requirement for different items one day in advance The store prepares the bins for line feeding on the basis of requisition. After keeping the items in bins for line feeding, store persons themselves prepare issue slips and these will be kept for future record. If item is not available in store and available in receipt area then store people will request quality for its urgent inspection. After quality inspection the item will be issued to production from receipt store itself. In that case receipt store persons will prepare issue slip.

This company is using Partial push system because issue is based on prearranged plan but production people are themselves coming to draw the item.

In the next section we will find the effect of system of issue on mismatch.

4.7.2 Basis:

On the basis of observations for issue system of different organisations we can divide issue systems in following two categories:

1) Category "A": Requisition is given after withdrawing the item. Ex. TELCO.
2) Category "B": Requisition is given before withdrawing the item. Ex: DUNCAN, GEC, LML.

If requisition is given after withdrawal then there is no cross-check to assure that item issued is as given in requisition. But if requisition is given before withdrawal then it can be verified during issue that part and quantity issued are same as given in requisition.

However we were not able to collect information regarding mismatches due to requisition slip for DUNCAN, GEC and LML. The study is confined only to analysis of mismatches observed in TELCO.

In TELCO, there are two type of systems prevailing for the record of the information regarding issue of the item, after being withdrawn by line feeders:

a)Issue register.

b)Bar coded slips.

We studied both the systems separately.

4.7.2.1 Study Of Issue Register:

In the issue register system, line feeders were recording information about part taken and quantity taken, after withdrawal. We observed two samples of 2360 entries and 800 entries respectively. We observed two type of errors in recording the data by data entry operator from issue register:

a) Error Due To Inability Of Data Entry Operator To Identify The Part Recorded By Line Feeder:

In some cases data entry operator records the issue as "PNP" i.e. "Part Not Present", as there is no corresponding part in the computer records. This entry is not recorded and

hence a discrepancy is created between computer and physical quantity of that item. So physical stock will become less than computer stock for the item which has been issued.

For the two samples observed, information regarding "PNP" is given in table 4.15.

Table 4.15 "PNP" in issue register of TELCO

Sample Number	Entries Studied	PNP	Transactions per PNP
1	2360	4	≈ 600
2	800	2	≈ 400

So on average there is one PNP per 500 entries.

Probability "p" of an issue coming under PNP = $\frac{1}{500} = 0.002$.

Per day there are about 500 issues, so in a year having 300 working days we estimate total number of issues = 500×300 = 150000

As total items in store are about 3000, so if we assume that each item is issued equal number of times in a year. So on average each item will be issued $\frac{150000}{3000} = 50$ times in a year.

If probability of an issue entry to become PNP is "p" Then the probability that there will be no mismatch due to PNP after "n" issue of an item = $(1-p)^n$.

In present case p=0 002 and n= 50.

So the probability that there will be no mismatch in an item due to PNP due to issue entry during one year = $(1-0\,002)^{50} = 0.9$.

Hence the probability that there will be mismatch due to PNP in an item due to issue entry in one year duration ≈ 10%.

b) Error Due To Incorrect Part Number Entry:

In addition to "PNP", errors are also created due to incorrect part entry by the line feeders. This error was observed either by noting corrections which may have been made by the line feeders themselves or entries with code 31, marked by data entry operator, which implies that correct part number has to be checked latter.

If the entries have been overwritten by same pen then there are more chances that line feeder himself has changed part code realising that he has done a mistake.

But if changes have been done by other pen then it is more likely that previous part number entered was wrong and was corrected by someone else later

For the two samples selected, the observations for the incorrect part number entry by line feeders are shown in table 4.16.

Table 4.16 incorrect part number entry in issue register of TELCO

Sample Number	Entries studied	Error of entering part code by line feeder	Transactions per error of entry by line feeder
1	2360	81	≈40
2	800	33	≈24

So on average there is one incorrect part number entry in 30 entries in issue register.

However it may be noted that, as the corrections are made by line feeders, such an error does not necessarily tantamount to a physical discrepancy or mismatch being created. However for the other correction i.e. made by data entry operator, chances of a mismatch created are more, as in finding the correct code for wrong part code of issue register there is human judgment involved. Item has already been withdrawn, so the actual part number to which the entry pertains can not be ascertained. The correction of wrong code is based on guess of data entry operator about probable item that would have been withdrawn. Due to this guess there are chances of making error i.e guessing part code different than the part actually moved

For getting an idea of error due to wrong guessing we examined sample of wrong entries which were corrected latter.

Among these entries we examined the entries in which code number after correction differed at least in three places out of twelve places for the original part code. Chances of error due to correction after guessing are high in such cases. We observed that out of 100 number of wrong entries studied, 16 entries had three or more digits wrong.

Using this figure of 16% as the estimate for the wrong guess, we estimate error introduced due to wrong guessing as follows:

The cases of wrong entry are one in 30 issue entries and estimate of error due to wrong guessing for these wrong entries is 16%. So the probability of wrong guessing "p" for an entry in issue register is $\frac{1}{30} \times \frac{16}{100} = 0.0053$

On average an item is issued 50 times in a year(refer to 4.7.2 1.a)

If probability of wrong guessing for an issue entry is "p". Then the probability that there will be no mismatch due to wrong guessing of incorrect part number entry after "n" issue of an item = $(1-p)^n$.

In present case p=0.0053 and n= 50.

So the probability that there will be no mismatch in an item due to wrong guessing of incorrect part number entry in issue register, during one year = $(1-0.0053)^{50} \approx 0.76$.

Hence the probability that there will be mismatch in an item due to wrong guessing of incorrect part number entry in one year duration ≈ 24%.

However we have not been able to verify the size of the error due to wrong guessing and our estimate can be on higher side.

We can summarise the results of above two observations as the error due to not knowing at all which part was taken will create 10% mismatches and error due to wrong entry of part code will create 24% mismatch out of total items at the end of year.

4.7.2.2 Study Of Bar Coded Slip System:

TELCO has recently introduced the system of bar coded slips to avoid error due to wrong part entry at the time of withdrawal. In this system each bin has a bar coded slip, with quantity and component number bar coded. When items are withdrawn then slips are handed over to issue counter. The slips are scanned to update the computer record.

We observed three major problems in this system:

- Wrong slip may have been placed in the bins.

- The quantity written on bar coded slip may be different than quantity actually present in bin.
- No slip is present in the bin.

First type of error will cause a physical discrepancy in two items, while second type of error will cause discrepancy in one item. Third rype of error will create a situation where at the time of withdrawal, no information will be recorded. Due to this, item will be physically moved but there will be no reduction in computer record and deviation will get generated

To check the effectiveness of bar coded slips we selected 50 locations distributed all over store and not limited to any particular section of store. This was done to ensure that our sample represent a random sample of warehouse. We collected information about bar coded slips at each location. We observed at each location, if one of the above mentioned three type of errors is committed. The results of our sampling is shown in table 4.17.

Table 4.17 Error in bar coded slips at TELCO

Locations studied	No Slip	Wrong Quantity	Wrong Slip
50	8	6	3

So there is error at 17 locations out of 50 locations. On the basis of this we estimate that there is error in the system of bar coded slips at about 34% locations.

When item will be withdrawn then either no requisition will be given(No slip case, error will be in 16% items due to this) or requisition given will be wrong (wrong slip or wrong quantity case; error will be in 18% items) There is no cross check to correct this error later as item has been physically moved.

From the observations, we conclude that while bar coded system is easy to implement, the chances of mismatch error seems to be same in both the systems, i.e. manual and bar coded system.

4.8 MEASUREMENT ERROR:

We will classify the mismatche due to measurement errors in two broad groups·

1) Mismatch due to human judgement of quantity for small items.

2) Mismatch due to error in manual counting for big items.

4.8.1 Mismatch Due To Human Judgement:

Accurate counting of small parts is often a problem. Bored material handlers make estimates instead of actually counting or, even if they do count, often make mistakes. Further, the counting of small parts is time consuming and expensive. Accuracy on the order of one part in a thousand are possible to achieve with the help of electronic counter which is much better than is possible with manual counting.[Young(1991)]

4.8.1.1 Basis:

For the purpose of finding mismatch introduced due to human judgement, we took samples of small items of weight less than 50 gm. Because for the size of these items, it is not feasible to count these items every time In the absence of electronic counter persons issue these items based on their perception of quantity.

To get the idea of error due to human perception we did sampling as below·

4.8.1.1.1 Observations In TELCO:

In this organisation we collected a sample of four small items kept in bins for line feeding, in issue store Being small, these items are not counted at the time of bin preparation. Instead of counting, human judgement is applied to estimate the quantity in bin. We considered quantity written by store person in tag/bar coded slip lying in bin, as "Quantity on Record". We verified the actual quantity present in bin by electronic counter and considered it as "Actual Quantity". We selected items under responsibility of different persons for sampling, so that our sample is more representative.

The results of sampling are shown in tables 4.18(a) to 4.18(d).

I. Table 4.18 (a) Error due to human judgement in Part "A"

Quantity written on tag	Actual Quantity in Bin	% Error (x)
150	133	-11.33
150	123	-185

II. Table 4.18 (b) Error due to human judgement in Part "B";

Quantity written on tag	Actual Quantity in Bin	% Error (x)
325	353	+8.62

III. Table 4.18(c) Error due to human judgement in Part "C";

Sl. No.	Quantity written on tag	Actual Quantity in Bin	% Error (x)
1.	1000	953	-4.7
2.	1000	893	-10.7
3.	1000	823	-17.7
4.	1000	875	-12.5
5	1000	929	-7.1
6	1000	883	-11.7
7.	1000	949	-5.1
8	1000	855	-14.5
9	1000	949	-5.1

IV. Table 4.18(d) Error due to human judgement in Part "D";

Sl. No.	Quantity written on tag	Actual Quantity in Bin	% Error (x)
1.	500	515	-3

The observations of above sample are only due to error of human judgement and not due to any other error like unauthorised removal etc.

From the above data percentage error due to human judgement has average $\bar{x}$=10.00%

and it is varying from 3% to 18%

Samples "C" and "A" show that if a person does overestimation then he overestimates consistently.

4.8.1.1.2 GEC:

In this organisation, we collected a sample of washers so that we can eliminate chance of error due to similar parts being issued. Washers can not be used in place of each other because its diameter is different and they are not available in different thickness for same diameter. This data was collected from the record of half yearly physical verification in this organisation.The results of sampling are shown in table 4.19

Table 4.19 Sampling for error due to human judgement of quantity in GEC

Sl. No.	Code	Item	Comp. Stock	Phy. Stock	Excess Qty.	Shortage Qty.	% error
1.	25320049	M.S. Plain punched washer M4	3310	3095	Nil	215	6.5
2.	25320059	M.S. Plain punched washer M5	198	192	Nil	6	3.0
3.	25320069	M.S. Plain punched washer M6	3800	3215	Nil	585	15.4
4.	25320109	M.S. Plain punched washer M10	3037	2694	Nil	343	11.3
5.	25320129	M.S. Plain punched washer M12	1535	1409	Nil	126	8.2
6.	25320089	M.S. Plain punched washer M8	810	513	Nil	297	36.7
7.	25310089	Washer 21O/D. 10.5I/D	1942	1042	Nil	893	46.0
8.	25310129	M.S. Plain punched washer M4	2931	2342	Nil	589	20.1
9.	25310209	Washer 37O/D. 21I/D	2307	2219	Nil	98	4.2

From the data in table 4.19, the average of percentage error due to human judgement is 16.8% and it varries from 3% to 46%. However this can be an overestimate, because these items were lying in store for a long period, and hence error can also be due to unauthorised removal.

In summary, we conclude that for small parts, for which manual counting is not feasible, there is error due to human judgement of quantity.

4.8.2 Error In Manual Counting For Big Items:

4.8.2.1 Basis:

Due to manual counting of items there exist chances of error. This error in manual counting will be more if person doing counting is careless.

To study the error due to manual counting, we selected the samples of items already counted by store people and we ourselves physically verified the actual quantity :

4.8.2.2 Observations :

4.8.2.2.1 TELCO

In this organisation batches are of large quantity both during receipt and issue(refer 2.2.2.1.b). We took observations for error in manual counting in following two areas:

I. Samples were taken in receiving area to get idea of error at the time of receiving.

II. Samples were taken in issue store to get idea of error occuring at the time of issue.

4.8.2.2.1.1 Observations in receiving area:

In the receiving area, we selected 4 samples at random of parts for which counting is required at the time of receiving After counting quantity found by store people is written on the tag attached with the lot This we considered as count reported. We ourselves verified the quantity in that lot to get actual number of items. This we have considered as count observed. The results of this sampling in receiving area is given in table 4.20.

Table 4.20 Observations for error due to counting in receipt section of TELCO

Part No.	Count Reported	Count Observed	Perc. Error	Notes
2574 5420 8205	400	395	1.3%	The packing was opened and counted for getting the actual quantity. Wt. around 100g.
2060 8150 8201	466	461	1.1%	small item
2516 4900 7502	200	199	0.5%	Shipped by supplier in bags of std. qty. 200. Wt. around 100g.
2632 4130 3304	39	38	2.6%	

Note : Approx. wt are given to get an idea about size of part.

One more reason for error in the above sample of receiving area can be due to the items picked up by quality department as sample for testing. To eliminate this error, samples were selected for lots which had been received at most one day before. Further it was verified from the quality that no item from these lots had been taken as sample for quality testing.

Items in these samples are double counted, first at supplier's end and second on receipt in receiving area, even then there is counting error.

4.8.2.2.1.2 Observations in issue store :

To get the idea of error in count during bin preparation for the purpose of issue, we did sampling in central material store Two items were selected at random in issue store for which counting is required at the time of bin preparation. After counting the required number of parts, the staff of issue store keeps this quantity in bin for line feeding. A tag is attached with this bin showing quantity in bin This we considered as count reported. To get the actual quantity lying in bin we counted ourselves the quantity lying in bin. This we considered as count observed. The results of sampling are shown in tables 4.21(a) and 4.21(b).

Table 4.21(a) Error due to counting in issue store for part "E"

Bin No.	Count Reported	Count Observed	Perc. Error
1.	55	49	10 9%
2	55	48	12.7%
3.	54	50	7 4%
4.	53	50	6.0%

Table 4.21(b) Error due to counting in issue store for part "F"

Bin. No.	Count Reported	Count Observed	Perc. Error
1.	100	96	4%

There are chances of carelessness by stock handler during counting for placing item in bin. This is because bin will go on line and hence there is no problem if count reported is different than count observed.

4.8.2.2.2 DUNCAN:

To study the effect of batch size on error due to counting, a sample of the items kept in receiving area was taken. The quantity written on tag attached with this lot was taken as count reported and counting was done ourselves to know the actual quantity. This was considered as actual count. The observations of our sampling are shown in table 4.22.

Table 4.22 Sample for error in manual counting in receiving area of DUNCAN

Sl. No.	Order number	Count Reported	Count Observed	Perc. Error
1.	ECC 1728	4	4	0%
2.	EJC 4134	12	12	0%
3.	ECC 2409	7	7	0%
4.	ECC 2049	35	35	0%
5.	ECC 2451	50	49	2%
6	ECC 2792	12	12	0%
7	ECC 1866	2	2	0%
8	EJC 4775	5 set	5 set	0%
9	ECC 1297	17 No	17 No.	0%
10	ECC 1271	20	20	0%
11.	60 550 103	6	6	0%

It can be observed that except one batch of size 50, all other batches did not show any error.

4.8.2.2.2 LML:

We selected sample from the items lying in receiving area randomly. We included only those items in our sample which have to be counted to know the quantity. In this area as per the information provided by receiving, items are received in bundles of 5, 10, 25 50 etc. We considered "count reported" as number of items in each bundle nearer to any of the above standard bundle size. In some cases number of items per bundle was also written on tag

attached with this lot by receiving person. We counted number of items in bundles of our sample and considered it as "actual count" The results of our sampling are given in table 4.23.

Table 4.23 Sample for error due to manual counting in receiving area of LML.

Sl. No.	Code No.	Qty. on paper	Actual Qty. 1. 2. 3. 4.				Perc. Error	Note
1.	C-1707164	25 per packing	25				0%	Big part
2.	C-0712547	5 per packing	5	5	5	5	0%	Big part
3.	C-4709813	10 per packing	10	10	10	10	0%	Medium sized part Wt. around 200 gm
4.	216740	5 per packing	5	5	5	5	0%	Medium sized part. Wt. around 300 gm.
5.	C-0712547	10 per packing	10	10	10	10	0%	Big part

Thus there was no error observed in case of LML

We may conclude that chances of mismatch will be more if batch size during receipt or issue is higher. Further small packing or bundeled items are likely to be correct in count.

4.9 CODING SYSTEM:

In a large warehouse it will not be feasible to remember the details of every item. So a record has to be kept for every item. This requires that each part or component should have a unique identifier. Part name can be one such identifier, however same part name can be written

in different ways, making it difficult to use. For example a part "Assembly Air Filter" present if TELCO can be written in following different ways by different people:

I. Assembly Air Filter

II. Assly Air Filter

III. Assl. Air Filter.

IV. Ass. Air Filter.

In addition in each of above four cases "Assembly" can be written by someone after "Air Filter" also instead of writing before as written in above cases.

In addition to above eight ways as different models are produced so one have to specify the model. This can be given either using "for" or not using "for" after above cases. For example:

a) Assembly Air Filter For 1610

b) Assembly Air Filter 1610.

So now total ways of writing the name become $8 \times 2 = 16$ There are also a lot of many other variations possible using punctuation marks etc As the name string have to match exactly with the name string of desired part already stored in database to get information about part from computer, it is clear that name can not serve our purpose for getting information. A coding system identifies a unique code for each part and in general used for name identification.

4.9.1 Requirements of a good coding system:

The basic requirements for a good coding system are as below

I. Each code should represent one and only one item

II. There should be one and only one code for every item.

III. The number of characters in a code should be as small as possible.

IV. Code should be easy to remember. This is only possible if we have some rational logic for every character of code.

Some of the logic for coding we observed in our study are

(a) place of use of item,

(b)nature of item(group and subgroup of item),

(c) Specifications of the item

(d) Serial number etc.(refer to 2.1.4.2, 2.2.4.2, 2.3.4.2 and 2.4.4.2).

Serial number are not desirable as they are difficult to remember and part identification become difficult. This problem was observed in GEC(refer 2.3.4.2).

V. Coding system should be able to deal with the addition and deletion of parts in future from part list

4.9.2 Observations For Mismatch Due To Coding System:

We observed following kinds of mismatch due to coding system:

1) Mismatch due to two different codes for same item based on different suppliers.

2) Error due to difference in units of measurement during issue and receipt.(unit code)

3) Problem due to different codes for same item based on different places of use.

4.9.2.1 Mismatch Due To Two Codes For The Same Item Based On Different Suppliers:

4.9.2.1.1 Basis:

If there are two codes existing for the same part then people will draw one part code item while they will give requisition for other part code for same item. Due to this error the part code actually withdrawn will become less than computer stock for this part code While the other part code for which requisition is given will become more than its computer stock. So there will be excess in one part code and shortage equal to same amount will be created in other part code for same item

4.9.2.1.2 Observations:

In TELCO we observed that there are some items which have two different part numbers for two different suppliers This problem is in all gauges like fuel gauge, pressure gauge, Amp. gauge etc. The reason of having two different part numbers for same item is that these items are supplied by different suppliers These suppliers have these standard items and they give only part numbers and no other detail is given to avoid chance of copying by other vendors. So for the purpose of record keeping different part numbers to same part are given.

But as parts are same, so many time people draw item of one company and give part code of same part by other company as issued. Due to this, discrepancy is created in both the

part numbers, one item showing shortage and other excess Table 4.24 shows sample of 7 groups of similar parts having different part numbers.

Table 4.24 Mismatch due to multiple code for the same part in TELCO

Sl. No.		Part No.	Part Name	Physical Stock	Computer Stock	Difference
1.	a.	2574 5420 9918	Fuel Gauge 12 V(P)	120	198	78(D)[1]
	b.	2574 5421 9992	Fuel Gauge 12 V(V)	520	436	84(E)[2]
2.	a.	2574 5420 9917	Amp. Gauge (P)	500	198	302(E)
	b.	2574 5421 9988	Amp. Gauge (V)	nil	381	381(D)
3.	a.	2574 5420 9919	Air Pr Gauge(P)	552	380	172(E)
	b.	2574 5422 9908	Air Pr. Gauge(V)	400	540	140(D)
4.	a.	2574 5420 9917	Amp Gauge(P)	540	318	222(E)
	b.	2574 5420 9988	Amp. Gauge(V)	800	962	162(D)
5.	a.	2573 4370 0108	Dual Break Valve	nil	210	210(D)
	b.	2573 4370 0144	Dual Break Valve	550	329	221(E)
6.	a.	2573 4370 0117	Air Brake Valve	500	802	302(D)
	b	2573 4370 0124	Air Brake Valve	500	202	298(E)
7	a.	2573 4310 0143	Unloder Valve	nil	160	160(D)
	b.	2573 4310 0122	Unloder Valve	250	114	136(E)

In each of the seven items in above sample, percentage error due to taking one part code in place of other part code of same item can be calculated as=

$$\frac{\text{Minimum of (Excess, discrepancy)}}{\left(\frac{\text{Excess} + \text{discrepancy}}{2}\right)} \times 100$$

Balance error may be attributed to other reasons like unauthorised removal etc. Percentage error due to two codes for same item and error due to other reasons in case of each item of sample above is shown in table 4.25.

[1] (D): Discrepancy in physical stock.
[2] (E): Excess in physical stock.

Table 4.25 Percentage error due to two part codes for same item in TELCO

Sl. No.	Percentage error due to two part codes	Percentage error due to other reasons
1	96	4
2.	88	12
3	90	10
4.	84	16
5.	97	3
6.	99	1
7	92	8

In the above sample average percentage error due two codes for same part is 92% and it is varying from 84% to 99% of total error in quantity. If there were no other errors except only due to giving requisition for one part code and taking actually same item of other part code then excess would have been exactly equal to shortage. But we are getting some error due to other reasons also (about 8% on average) because errors due to unauthorised removal etc. are also taking place

4.9.2.2 Error Due To Difference In Units Of Measurement During Receipt And Issue: (Unit code)

In subsequent sections we will consider the effect on mismatch due to units of measurement being different during receipt and issue

4.9.2.2.1 Basis:

If unit of measurement for an item is different at the time of receipt and issue then this may create mismatches. The mismatches can be due to two reasons:

1) Units of receipt and issue might be measuring completely different attributes. For example nuts and bolts are received in bags of standard weight but they are issued in numbers. At the time of receiving it is assumed that number of nuts and bolts for a packing of standard weight are already known. But this is not correct because weight of unit piece will vary from lot to lot. So for a standard weight number of units will also vary from lot to lot.

2)Units of measurement during receipt and issue may be different but both units of measurement may be corresponding to same basic attribute of item. Basic attribute of item for which we do measurement can be count, weight, length, area, volume etc. While units of measurement corresponding to these attributes can be set, number; Kg, gram; meter, centimetre, foot, inch; Sq. meter, sq. centimetre, sq inch; litre, cu. meter etc. So it may be the case that unit of receipt is in set but unit of issue is in number Both are measurements for the same attribute i.e. count. While in previous example for nuts and bolts attribute measured during receipt was weight and count during issue. In the second case mismatch will get created if physically item is received/issued in one unit and in computer entry has been made in other unit of same attribute. Due to both of above reasons mismatch will get generated.

4.9.2.2.2 Observations:

Our study to this problem is limited to only one organisation of our study, DUNCAN. Our observations are as follows:

a)Error due to difference in units of measurement during receipt and issue:

Items like nuts, bolts and other items of daily use like duster, hand gloves etc. are purchased in weight but issued in numbers Due to this there is a deviation between physical and computer stocks. For example last year there was a surplus of 1400 dusters due to this specific reason only The manager store informed us that the weigh of each duster is varying between 35 to 40 gram. So it is not a valid assumption that a standard weight of bag of duster will be having a standard quantity also

Some items are supplied by supplier in pair or set only. Examples of these items are belts used in motors, "O" rings etc. But at the time of issue it can be issued in numbers also in addition to pair and set. If issuing person is not aware of this fact, then for requisition of one single piece he can issue one set or pair because this pair or set has come from supplier in one single packing. Due to this a deviation will get generated between physical and computer stocks. This is because in computer issue will be shown of one number while physically issue was for one set or pair.

There may also be some cases when error can be at the data entry stage, where data entry operator has entered issue of one set/pair in computer stock. while requisition was given

for one piece and not for one pair/set, and physically also only one piece of the item was issued. One typical example of this is that item code 60.517 011, Oil seal lying at location B-108 D3 is purchased in sets One set consist of 2 pieces Plant person had given requisition for one piece only and actually also only one piece was issued. However at the data entry stage issue of one set was made. Hence there was becoming an excess of one piece in this item.

b)Sampling for error due to difference in units of receipt and issue:

To study the problem of deviation between physical and computer stocks due to difference between units of receipt and issue we studied a computer data sheet of items having different units of receipt and issue. In this data sheet corrections were done after doing physical verification of stock. We observed that out of 100 entries, there were corrections in 14 items. So we estimate that there is mismatch in around 14% items for which units of receipt and issue are different.

We further verified this fact by getting an estimate from the person who does reconciliation for the discrepancy after physical verification. We were informed that 10-15% mismatches can be assigned due to difference in unit of measurement during receipt and issue.

As there is total deviation in around 10% of the items (refer to 3.1.1.1), we estimate that mismatch in around 1 0% to 1.5% of total items in warehouse is due to units of receipt and issue being different

In summary, we conclude that there is mismatch due to units of receipt and issue being different for an item.

4.9.2.3 Mismatch due to different codes for same item based on different places of use:

4.9.2.3.1 Basis:

If part code is on the basis of place of use of the item then as same part can be used at different places, the same part will be having different codes. It may happen some times that parts "A" and "B" are same but they are having different codes due to their different places of

use. It is possible that for such items one item code "A" may show stock out, while other code "B" may show positive stock. If requisition is raised for item "A", although item (with differebt code) is lying, will not get issued Hence this is a special case of mismatch when both physical and computer stocks are OK for item "A" but it is physically lying in store under code "B". This type of problem will not be there if some characteristic of item is used for part code instead of point of use or a link is associated in the database for such codes.

4.9.2.3.2 Observation:

We illustrate this mismatch through one specific example we observed in one of the organisations of our study.

In this organisation the part code was different for different sections on the basis of point of use for same item. One large electric motor was needed by one section. The market price of this motor was three crores of rupees. When organisation contacted the supplier which supplies those kind of industrial motor, then one person of the supplier company informed that this item is already lying in the store of company under the part code of a different section. This person was previously working in the company under study. This electric more was kept in a special room made for this motor only.

If this kind of "False stockouts" can happen for such a costly item, then for low value items for which less control is exercised by managers, they can happen more frequently.

In summary, we conclude that there will be mismatches due to having more than one part code for same item.

5

CONCLUSION

5.1 THE STUDY:

In this dissertation we have made an attempt to understand the relationship between warehouse structure, product structure, warehousing practices and procedures, and the mismatch between physical and computer stock The study has been conducted by examining in detail the warehouses of four major manufacturing organisations The warehousing practices, procedures, control system and configuration were observed in each of these organisations and information regarding mismatches was compiled using available records, physical sampling, interviews with store, production persons, and managers

One of the major limitations of this study is the nature and quality of data and information available. As the nature of record, level of record keeping, warehousing practices and management practices were different for each of these organisations, no standard format for getting the information/data could be used. Methodology used have been primarily to observe the warehouse and collect whatever information can be collected and analyse it latter.

As the study was aimed at understanding the causes of mismatches, in physical and computer (or paper) record, following measure for such mismatch was considered:

"The percentage of items in which there is a mismatch between the physical stock and computer record"

A secondary measure as percentage of deviation between two records also have been considered to understand the impact of few specific factors.

In addition some secondary indicators like mismatched shipment, false stock-outs etc. are also used to explain the relationship between some factors and mismatches.

From the warehousing procedures, nature of product, nature of warehouse and management practices observed for the organisations we studied, we identified following factors for understanding the causes which leads to mismatches:

(1) Factors which are due to nature of product and organisational structure, e.g.,

(a) Product structure(end use of the product, job specific items) and Warehouse physical structure.

(2) Factors which are due to procedures and warehousing practices. This included:

(a) Location policy

(b) Multi item location at a single location

(c) Quality inspection policy

(d) Issue system

(e) Measurement error

(f) Coding system.

(3) Factors which reduce the chances of mismatch and include

(a) Computerisation.

(b) Physical Verification

(c) Access to store

We analysed the mismatches for the organisations we studied, for each of the factor and summary is provided in table 5 1 and table 5.2.

5.2 SUMMARY:

Table 5.1: Factors affecting mismatch in different organisations of our study:

1. Product structure

(a)

Sub-factor	Error Description	DUNCAN	TELCO	GEC	LML	
Level of standardisation	Creates error in two items at the same time	Medium	High	Low	Not observed[1]	**Level**
		1.5% -2.0% of total items	No error	upper limit of 23.4% items	Not observed	**Error**

(b)

Sub-factor	Error Description	DUNCAN	TELCO	GEC	LML	
Job specific items	reduces the chances of mismatch	Not applicable[2]	Not Applicable	High	Not applicable	**Level**
		Not applicable	Not applicable	Nil	Not applicable	**Error**

[1] "Not observed" refers that observation for that factor was not taken in the organisation

[2] "Not applicable" refers that factor is not applicable for that organisation.

(c)

Sub-factor	Error Description	DUNCAN	TELCO	GEC	LML	
Use of item	Mismatched Shipment	Maintenance Part	Standard Design Product	Customised product	Standard Design Product	Level
		No mismatched shipment	About 90 cases in a year	No mismatched shipment	100 cases in first 8 months	Error

2.&3. Computerisation and Physical Verification system:

Factor	Error Description	DUNCAN	TELCO	GEC	LML
Level of Computerisation	Reduces chances of mismatch (controlling factor)	Medium	Low	Medium	High
Level of physical verification (PVR)[1]	Corrects existing mismatches	0.66	0.04	0.25	0.11
% level of mismatch		10%	88%	30%	9%

4. System of storage of items:

(a)

Sub-factor	Error Description	DUNCAN	TELCO	GEC	LML	
Location policy		Random location system	Fixed location system	Informal system with many persons storing and issuing in the same area	Random location system in FIFO; Informal system in NON-FIFO but only one person operating in one area	Level
	False stock outs	No False stock out	No False stock out	Atleast one per day	No false stock out	Error
	Mismatch of locations	1.5%-2.0%	Not observed	Not applicable	3.5% in FIFO section	Error

(b)

Sub-factor	Error Description	DUNCAN	TELCO	GEC	LML	
Multi item location	creates error in two items at the same time	More than one item at a location	One item at a location	One item at a location	One item at a location	Level
		1) 8% of total issues. 2) 1-1.5% of total items	Not applicable	Not applicable	Not applicable	Error

[1] Level of physical verification $PVR = \frac{\text{Items physically verified in a year}}{\text{Transactions in a year}}$

5. Quality inspection policy:

Factor	Error Description	DUNCAN	TELCO	GEC	LML	
Quality inspection policy	Sample drawn for destructive and non destructive testing not adjusted. Creates error in one item.	Generally no quality tesung	Destructive as well as non-destructive testing	Non-destructive testing	Destructive as well as non-destructive testing	Level
		Not applicable	1)Always error of 1-2 items due to destructive testing. 2) Error of 1.2 items due to non-destructive testing in 33% of received lots	Not observed	Always error of 1-2 items due to destructive testing	Error

6. Access to store:

factor	Error Description	DUNCAN	TELCO	GEC	LML	
Access to store	Unauthorised removal creates error in one item.	Medium Access in unlocked and No access in unlocked area	Full access in central material store and Low Access in rejection and scrap area	Medium Access in main issue store and No Access in other stores	Low Access	Level
		2.5%-3.0% in unlocked and 0.5% - 0 6% in locked area	30% in Full Access and 1% in Low Access	6% in Medium Access and nil in No Access stores	1.7%	Erro r

7. Issue system:

(a)

Sub-factor	Error Description	DUNCAN	TELCO	GEC	LML	
Entry in issue register	Wrong entry not identified	Not observed	10%	Not applicable	Not observed	Error
	Wrong guessing of incorrect entry	Not observed	24%	Not applicable	Not observed	Error

(b)

Sub-factor	Error Description	DUNCAN	TELCO	GEC	LML	
Bar coding system	No slip or wrong quantity slip (creates error in one item during issue)	Not applicable	28% locations	Not applicable	Not applicable	Error
	Wrong slip of other part (creates error in two items at a time)	Not applicable	6% locations	Not applicable	Not applicable	Error

8. Measurement error:

(a)

Sub-factor	Error Description	DUNCAN	TELCO	GEC	LML	
Mismatch due to human judgement of quantity	creates error in one item. Applicable for small uncountable items	Not observed	average 10%; varying from 3% to 18%	upper limit 16 8% varying from 3% to 46%	Not observed	Error

b)

Sub-factor	Error Description	DUNCAN	TELCO	GEC	LML	
Error in manual counting	Creates error in one item Applicable for countable items	0-2%	0.5%-12 7%	Not observed	nil	Error

9. Coding system

a)

Sub-factor	Error Description	DUNCAN	TELCO	GEC	LML	
Two codes for same item	Creates error in two items	Not observed	mismatch in quantity for such parts is 92% due to this reason	Not observed	Not observed	Error

b)

Sub-factor	Error Description	DUNCAN	TELCO	GEC	LML	
Difference in units of receipt and issue (unit code)	Creates error in one item at a time	1-1 5% of total items	Not observed	Not observed	Not observed	Error

Table 5.2 Approximate Break-up of total mismatch in organisations under study:

Main factor	Sub-factor	DUNCAN	TELCO	GEC	LML
Total Error		10%	88%	30%	9%
Product structure	Level of standardisation	1.5-2.0%	Nil	upper limit 23 4%	Not observed
	End use of item(mismatched shipment)	Nil	3%	Nil	5%
System of storage of items	Mismatch of location	1.5%-2.0%	Not observed	Not Applicable	3.5% in FIFO section.
	Multi-item location	1.0%-2.0%	Not applicable	Not applicable	Not applicable
Quality inspection policy	Destructive testing	Not applicable	1-2 items per lot due to destructive testing.	Not applicable	1-2 items per lot.
	Non-destructive testing	Not applicable	1-2 items for 33% of lots received.	Not observed	Nil
Access to store	Unauthorised removal	2.5-3 0%	30%	Lower limit 6%	1.75%
Issue system	wrong issue entry could not be identified	Not observed	9%	Not applicable	Not observed
	Wrong guessing of incorrect issue entry	Not observed	24%	Not applicable	Not observed
Measurement error	Error due to human judgement of quantity	Not observed	10% of quantity	Upper limit is 16 8% of quantity	Not observed
	Mismatch due to manual error in counting	0-2% of quantity	0.5% -12.7% of quantity	Not observed	Nil
Coding system	Difference in unit code of receipt and issue	1.0-1.5%	Not observed	Not observed	Not observed

5.3 CONCLUSION:

On the basis of our analysis for various factors affecting mismatch, we have identified following relationship between factors influencing mismatch and the mismatch error:

1. Product structure:

a) **Level of standardisation**: Standardisation has considerable impact on the mismatches. Mismatches get reduced considerably with higher level of standardisation

b) **Job specific Items**: The level of mismatch in job specific items is very less.

c) **End Use of Item** For organisations in which same item is regularly used, chances are higher of receiving physical supply different than item supplied on paper. This is due to higher chances of getting such supplies accepted as the material will be needed later.

2. Computerisation Higher level of computerisation improves the effectiveness of overall warehouse management system. Hence higher level of computerisation reduces overall level of mismatches considerably. Also higher level of computerisation helps in improving shelf life considerably due to better control.

3) Physical verification system: Some form of physical verification system is used in each organisation to correct the existing mismatches. Higher will be the number of items physically verified in a year as compare to total issues, higher will be the inventory accuracy.

4) System of storage of items

a) **Location policy** Problem of "False stock outs", i e item is present physically in the store but it could not get located at the time of issue requirement, is observed in informal system of locations when number of persons are storing and issuing in the same area.

b) **Mismatch of location**: In random location system, there are chances of keeping item in the store, other than at its location as per record At the time of issue, misplaced item has to be searched in entire warehouse, which may be very time consuming job for a big warehouse.

c) **Multi item location**: If more than one item is stored at the same location, then there are chance of issuing wrong item from the location at the time of withdrawal. This imparts mismatches in both the items, i.e., item requisitioned and item actually issued.

5) Quality inspection policy:

a) **Destructive testing**: Generally care is not taken to adjust the items consumed in destructive testing for quality inspection, due to quantity being very small for a lot(generally one or two). But after receiving a number of such lots, a substantial mismatch is created for an item.

b) **Non - destructive testing**: If sample drawn for non-destructive testing are not returned back in original lot then mismatches get created.

6) Access to store: Access to store has a very significant impact on mismatches. Higher level of access to store, increases level of mismatch considerably, predominantly due to unauthorised removal To control the unauthorised removal, only authorised persons should have access to store.

7) Issue system. Manual system of entry into an issue register is prone to incorrect entries, entries not being made and results in considerable mismatches. We also observed that although bar coded system is easy to implement, the chance of error seems to be same in both manual and bar coded system of issue entry, due to bar coded slips being misplaced.

8) Measurement error:

a) **Error due to human judgement of quantity for small items**: For small items, for which manual counting is neither feasible nor desirable, chances of mismatches are significant due to error in human judgement of quantity

b) **Error due to manual counting**: For big items, which have to be counted manually to verify the quantity, chances exist for error in manual counting Further small packing are likely to reduce the error in manual counting.

9) Coding system:

a) **Two codes for same item** There are very high chances of mismatch if two codes exist for the same item.

b) **Difference in unit codes of measurement during receipt and issue**: Different codes during receipt and issue for an item increases the chances of error both during issue and data entry of issue into record. Hence the chances of mismatch get increased.

c) **Coding system based on location of use**: If coding system is on the basis of location of use of item, then there may be multiple codes for same item due to different places of its use. This can result in a situation where an item could not get issued due to nil stock but at the same time it is lying in store under different part code.

5.4 Observations For Good And Bad Practices In Organisations:

During our study we observed few warehousing practices, which are desirable and the other which are undesirable. We summarise such practices in this section.

Following are good and bad practices observed in different organisations.

1. DUNCAN:

a: Good practices:

1. Items of daily use are kept in locked area.
2. Specialists are used for physical verification and reconciliation throughout the year.

b. Bad practices:

1. More than one item is kept at one location.
2. No person of store is present for night issue.

2. TELCO:

a) Good practices:

1. Bar coding system is under implementation.

b) Bad practices:

1. No location is marked in receiving area.
2. Received items are kept on rollers due to which some times bins topple down.
3) Line feeders have full access to draw any item from store.
4) Requisition is given after withdrawal.
5) There is no provision for entry into computer when item is transferred fro receiving store to issue store.

3. GEC:

a) Good practices:

1. There is system of main gate entry into computer so that every one knows about receipt of material inside factory.
2. Receiving area, rejection and scrap store and other stores except main issue store are locked.
2. Locations are numbered in receiving area.
3. Requisitions are raised on computer.
4. Code represents specification of item

b) Bad practices:

1. No store person is present for night issue.

4. LML:

a)Good practices:

1. Items are received in bundles of 5, 10, 25 or 50 items.
2. Requisition for next day are raised one day in advance.
3. Colour of store and production bins are different.
4. Locations are numbered in receiving area.
5. Samples to quality are given and taken back by store
6. There is provision of entry into computer system of emergency issue from receiving section.
7 There is system of quality consumed to adjust items used by quality in destructive testing.

5.5 Avenues For Future Work:

Further study can be carried out to find the impact of organisational structure, motivation of warehouse personnel and automation on mismatch. In addition present study need strengthening by supplementary study with more data and information.

Another study can be carried out to find the validity of our assumption that there is no error just after doing physical verification in periodic count method. This is due to the reason that periodic counts are carried out within the limited time and also physical verifiers are

generally not responsible for keeping inventory record accurate So they may not give it very much importance. More chances of committing mistakes are also due to the fact that they are not specialists for doing physical verification.

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